THURSDAY, DECEMBER 4, 1919.

THE NURTURE OF KEY INDUSTRIES.

THE Bill "to constitute a Trade Regulation Committee, to regulate the importation of goods with a view to prevent dumping, safeguarding key industries and industries affected by the depreciation of a foreign currency," which Sir Auckland Geddes introduced in the House of Commons on November 19, will no doubt meet with strenuous opposition. It is, of course, anathema to the out-and-out Free Trader, and will be viewed with some doubt and suspicion even by those who, while not hide-bound by fiscal shibboleths, are yet distrustful of the bureaucratic control which the Bill would seem to entail. The terms of the amendment for its rejection on second reading, tabled by Mr. Wallace, one of the Coalition Liberals, are obviously drafted so as to secure the support, not only of the convinced Free Trader, but also, if possible, of those who object to all departmental control of our commercial relations.

As regards the Bourbons of the Manchester school, who learn nothing and forget nothing, Mr. Wallace is preaching to the converted; probably no argument will have the slightest effect upon them. They will find nothing in the changed conditions of the world, in the circumstances of the Empire, or in the influence of the war on our home industries to induce them to modify their convictions in the smallest degree. To them the basic principle of Free Trade has something of the sanctity of Holy Writ. It has all the force of a natural law as fixed and immutable as seemed to them the law of gravitation. But they may be reminded, as recent events have shown, that even the law of gravitation may possibly have a less stringent universality than we have hitherto been content to assume. How much more probable is it, therefore, that a so-called economic law depending upon fallible and transitory human conditions may be at least equally invalid and fundamentally more unsound.

The argument against bureaucratic control will no doubt appeal to a considerable body of public opinion. The Legislature, under the direction of the Government, has of late been steadily riveting the chains of this control in a variety of directions, and there is a growing impatience with the policy. It is a sort of aftermath of the war which the country will not tolerate to an indefinite extent. During the continuance of the war, when the free play of individualism might conceivably interfere with a united national effort, guidance and control by a Government which we had entrusted with the safeguarding and direction of our destiny were not only accepted, but also generally recognised as imperatively necessary. But under normal conditions the continuance and possible perpetuation of bureaucratic control is wholly opposed to the genius of the English people, as past experience has abundantly proved, and is certain to be fiercely resented sooner or later.

It may be argued, of course, that the times are not yet normal, and no doubt this consideration will appeal to many who would otherwise be disposed to reject the Bill *sans cérémonie*. The allegation that it is bound to impose an intolerable burden upon manufacturers, traders, and consumers, and that it is calculated to maintain high prices and arrest our rapid industrial recovery and development, of course, begs the question. It is at least arguable that the provisions in the Bill against dumping and for the safeguarding—we purposely omit the word "protecting," as a term of offence to some people—of key industries are really calculated to assist our industrial development, even although they may tend for a time to maintain high prices. Excessive cheapness has not hitherto proved the panacea for all human ills which some, in the past, would appear to have claimed for it.

Although the House of Commons is invited by the amendment to reject the Bill, it will be observed that in the Trade Regulation Committee which it is proposed to set up, and which is to be responsible for the working of the measure, the majority is to consist of members of that House nominated by the House itself. The measure, therefore, is not, strictly speaking, bureaucratic in the sense in which this term is usually understood. It is presumably intended that the representatives of the people, being in the majority, should exercise an effective control of its operations. It rests with the House of Commons to nominate persons of knowledge and experience in commercial and industrial matters, who would keep themselves in touch with the views of the trade organisations in the country, and who may be trusted to check any undue departmental interference or restriction, and to expedite, when necessary, departmental activity. Is the House so distrustful of its power, or of the ability of its members to cope with the permanent departmental officials, that it is to be asked to reject the measure on the ground that it is too "bureaucratic"?

There is much in the Bill of a highly technical character, and even experts are certain to differ

as to the true meaning and effect of some of its provisions. Many of its terms are capable of various interpretations, and cases are certain to arise the equitable solution of which will tax the judgment and wisdom of the Committee. But the general sense of the House will, it is to be hoped, perceive that the measure is based upon the requirements and necessities of the times. This consideration ought surely to mitigate the factious opposition with which it is threatened.

No doubt the Bill will be modified in its passage through Parliament. It is certainly capable of amendment in some details. But it is to be hoped that the Government will stand firm in its effort to safeguard the key industries. The list of these named in the Second Schedule is considerably shorter than that drawn up by manufacturers' associations, and much of it is too technical to be within the comprehension of the average member of Parliament, who has little or no knowledge of science. It may be that the events of the last four or five years have made him acquainted with a certain amount of chemical terminology, but the list of articles enumerated in the first two sections of the Schedule dealing with synthetic colouring matters, drugs, "intermediates," and "fine chemicals," is sufficiently deterrent to the lay mind, and scarcely lends itself to effective party debate. It is to be regretted that at the present juncture no acknowledged representative of chemical science is a member of the House—no one of the authority and knowledge, perspicacity and breadth of view, for example, of the late Lord Playfair or of the late Sir Henry Roscoe. It is certain that, whatever might have been the views of these distinguished men concerning the fiscal policy of the Bill, they would be in hearty sympathy with the effort to resuscitate and strengthen an industry which had its rise in this country, and in all probability would never have sunk into partial insignificance had Parliament dealt earlier with the admitted deficiencies in our system of national education.

The Schedule may be said to have its origin in the war, and to embody some of its lessons. It is the direct result of the painful experience of our shortcomings as revealed to us on its outbreak. Some of the industries with which it is concerned are at present not much beyond their initiatory stage, but, as has been proved, they are all more or less necessary to our national welfare, and in the light of our recent experience it would be the height of unwisdom not to do everything in our power to place them on a permanent and independent basis. We are at the parting of the ways, and on the House of Commons rests the serious responsibility of choosing the right path. To neglect the present opportunity, or to be blind to its significance, would be an irreparable disaster.

THE DRAGON OF MYTHOLOGY.

The Evolution of the Dragon. By Prof. G. Elliot Smith. Pp. xx+234. (Manchester: At the University Press; London: Longmans, Green, and Co., 1919.) Price 10*s.* 6*d.* net.

THE dragon may be regarded as the most venerable symbol employed in ornamental art, and it has been the inspiration of much of the world's great literature in every age and clime. The dragon-myth also represents the earliest doctrine or systematic theory of astronomy and meteorology. The study of dragon-lore thus leads us back to some of the most primitive workings of the human mind, and embraces many subjects which at first sight seem to have little connection with the end in view. Prof. Elliot Smith's work on the evolution of the dragon, indeed, alludes to almost every aspect of primitive thought and myth, and the author discusses questions which vary from the origin of embalming to the worship of the cow, the elixir of life, the swastika, and the reasons for wearing clothes. His volume consists of notes of three lectures delivered in the John Rylands Library, Manchester, illustrated by beautiful reproductions of an appropriate series of drawings. The chapters are entitled respectively Incense and Libations, Dragons and Rain Gods, and The Birth of Aphrodite.

Prof. Elliot Smith maintains that the dragon was originally a beneficent creature, the personification of water. The fundamental element in the dragon's powers was the control of water, whether rivers or seas, pools or wells, or clouds on the tops of mountains. The substratum of its anatomy usually consists of a serpent or a crocodile, with the scales of a fish for covering, the feet and wings (sometimes also the head) of an eagle or hawk, and the fore-limbs (sometimes also the head) of a lion. All the parts are symbols of the various attributes and uses of water in Nature. With various slight additions and modifications, this composite wonder-beast ranges from western Europe to the far east of Asia, and thence across the Pacific to America. It must, indeed, have had a common origin, and Prof. Elliot Smith particularly emphasises the interest of the American version, which he regards as having gradually evolved from several successive importations of ideas from the Old World. He remarks that "one and the same fundamental idea, such as the attributes of the serpent as a water-god, reached America in an infinite variety of guises, Egyptian, Babylonian, Indian, Indonesian, Chinese, and Japanese; and from this amazing jumble of confusion the local priesthood of Central America built up a system of beliefs which is distinctively American, though most of the ingredients and the

principles of synthetic composition were borrowed from the Old World."

The lecture notes are unfortunately somewhat scrappy, and Prof. Elliot Smith apologises for the circumstances which led both to this defect and to the not infrequent repetitions. The book also lacks an index, which would add much to its usefulness. It is, however, a veritable mine of information on the subjects with which it deals, with numerous references to literature, and science is indebted to the John Rylands Library for undertaking the publication.

EUGENICS.

(1) *Lectures on Sex and Heredity delivered in Glasgow, 1917–18.* By F. O. Bower, J. Graham Kerr, and W. E. Agar. Pp. vi+119. (London: Macmillan and Co., Ltd., 1919.) Price 5*s.* net.

(2) *Eugenics and Environment.* By Prof. C. Lloyd Morgan. Pp. 82. (London: John Bale, Sons, and Danielsson, Ltd., 1919.) Price 2*s.* net.

(3) *La Sélection Humaine.* By Prof. Charles Richet. (Bibliothèque Scientifique Internationale.) Pp. iii+262. (Paris: Librairie Félix Alcan, 1919.) Price 6.60 francs.

THESE three books illustrate three somewhat different methods of setting the problem of eugenics before the general reader. The aim of the excellent little book by Prof. Bower, Prof. Graham Kerr, and Dr. Agar is to set forth the indispensable facts and principles, and leave the reader to draw the moral. It is not perhaps intended to deal with eugenics at all, but it is one which enthusiasts for eugenic propaganda will find very valuable. It consists of six lectures on the more elementary facts of sex, reproduction, and heredity in plants and animals. The first four lectures, two on plants and two on animals, deal with the subject in the two kingdoms in similar fashion, beginning with examples of reproduction and conjugation (syngamy) in the Protista, and passing through the simpler Metaphyta and Metazoa to the more complex phenomena of the highest plants and animals. No one who has a natural interest in living things, but has had no systematic training in biology, can fail to find these lectures interesting; those on plants are perhaps unnecessarily technical here and there, but with the assistance of the excellent illustrations any reasonably educated person should find them easy and interesting to read.

In the last two lectures Dr. Agar takes up the subject of heredity, begins with the phenomena of fertilisation, cleavage, and the early segregation of the germ-cells in Cyclops as an introduction to the conceptions of soma and germ-plasm and the material basis of inheritance, and then proceeds to give a short but lucid account of Mendel's law. In the last lecture he takes up heredity in Man. He points out that, since the characters in Man which are known to follow Mendel's law are comparatively few, and in general of small practical importance, human heredity must be studied in practice chiefly by the statistical methods of the biometric school. Of these he gives a lucid elementary description, illustrated by actual examples taken from the papers of Pearson, Heron, Schuster, and others, and shortly points out the bearing of the facts on eugenic proposals.

(2) Prof. Lloyd Morgan's little book is frankly an elementary text-book of eugenics. It deals with variation in human characters as illustrated by the normal curve of error, the principles of correlation, and the method of finding the correlation coefficient, very shortly with Mendelian heredity, and finally with acquired characters, selection, and the relation of biological characters to social tradition and civilisation. It is written in a pleasant and almost colloquial style, but suffers not infrequently from a certain obscurity of diction—*e.g.* in describing a correlation table (p. 33): "Along the left-hand vertical side the stature of the sons is given *in ascending order read downwards*" (our italics). Again, on p. 32 a misleading definition of perfect correlation is given, which is corrected at the bottom of the same page, a treatment which does not conduce to clearness. On p. 47 there is, doubtless by a slip, the misleading statement: "If blue eyes mate with brown eyes, one child in four may be blue-eyed." We feel also that the booklet suffers from being illustrated by purely imaginary examples the simplicity of which may give a false impression. Dr. Agar's account of biometric methods compares favourably with it in this respect. Nevertheless, it is in most respects an admirable elementary introduction to the subject, such as might well be used by those who wish to follow it up more fully by further reading.

(3) Prof. Richet's book has more of the character of an essay. It does not profess to set forth specific facts, but takes the facts for granted, and discusses the conclusions to be drawn from them. The main thesis of the author is that if selection can do such great things with domestic animals and plants, it could, if applied, do equally great things with man, and that the only hope for mankind in the future is in its application. The aim of life is happiness; progress is the increase of total happiness; this can be gained through science alone; it is limited only by the limits of the human mind, and these limits might be almost indefinitely extended by suitable selection. Selection must be of several kinds. In the first place, the white race is indisputably superior, and crossing with black or yellow gives bad results. All race-crosses must therefore be prohibited. Within the white race all defectives must be prevented from reproducing; seriously defective infants must not be allowed to live, and those found defective in later life must be segregated. Finally, positive encouragement must be given to marriage of the superior, especially between those superior in the same respect. The author's enthusiasm leads him at times to rather wild statements. He calls deaf-mutes (*sourds-muets*) "ces ébauches d'humanité, ces produits disgraciés . . . ces pauvres avortons," words which can only dis-

gust those who know the brilliant gifts of some who are thus afflicted. He states categorically that the mental improvement due to education is transmitted to offspring, and recommends late marriage of the highly educated in order that the effects of education may be more fully handed on. And neither Prof. Richet nor Prof. Lloyd Morgan seems to realise the extreme difficulty of eliminating an undesirable character if it is recessive in inheritance. In a stable population, if 1 per cent. show a recessive character, 18 per cent. will bear this character concealed by the corresponding dominant, and by preventing the reproduction of the 1 per cent. in which the recessive is homozygous, only very slow progress will be made in eliminating it. Prof. Richet is an enthusiast for eugenics, and has written an entertaining book, but one which is scarcely sufficiently abreast of modern work on heredity.

L. D.

OUR BOOKSHELF.

Essays in Common-sense Philosophy. By C. E. M. Joad. Pp. 252. (London: The Swarthmore Press, Ltd., 1919.) Price 8*s.* 6*d.* net.

IF any man of science, perplexed at the disturbing challenge which philosophy throws down to the assumptions as to plain matter of fact on which science rests, wants comfort and support for his intellectual framework from within philosophy itself, he will find and certainly enjoy it in the delightfully clear essays of Mr. Joad. It is a somewhat unusual thing for a young writer to make his *début* in philosophy by rejecting every temptation to paradox and any attempt to startle the "plain man," and setting himself the apparently easy but really very difficult task of convincing the "plain man" that his views about the universe are not likely to be very far removed from truth. Yet this is what Mr. Joad sets out to do.

Mr. Joad is not a very trustworthy guide when he discusses famous philosophical theories. He adopts too easy a classification, with the consequence that we find ourselves in strange company. All philosophers, past and present, are in his view representationists, solipsists, or realists. But this does not in the least spoil our enjoyment of the concise and easy way in which the writer finds himself at home in philosophy, of the keenness of his wit, and of the dexterity of his cut and thrust. There is only one of us who comes in for unstinted praise—Prof. Dawes Hicks—and we believe he does not recognise his theory in Mr. Joad's exposition. The rest of us—Bergsonians, pragmatists, absolutists—are all alike well trounced.

There is one thing in Mr. Joad's own view, however, which is very puzzling, not to say disconcerting. He tells us that sensible objects exist "very much" as we know them. But why not altogether so? If there is any difference at all, why is he so confident it can only be a very little one?

H. W. C.

Modern Engineering Workshop Practice: A Text-book for the Use of Engineering Students, Apprentices, and Engineers engaged in Practical Work. By Herbert Thompson. (Griffin's Scientific Text-books.) Pp. xi+328. (London: Charles Griffin and Co., Ltd., 1919.) Price 9*s.* net.

THIS book is an attempt to give a fairly comprehensive view of modern engineering workshop practice, and includes sections dealing with general methods and machines, and others dealing with special processes and machines, such as turret lathes, spiral milling, grinding, hardening, tempering, annealing, autogenous and thermit welding, and soldering and brazing. The author is quite at home in these branches. The descriptions are clear, and whilst many of the illustrations are half-tone reproductions of photographs of machines and appliances, there is a sufficient number of line drawings to enable the reader to understand the construction. The author is not so happy in chap. i., which deals with materials. Thus, on p. 3 we read, under the paragraph heading "Malleable-iron Castings": "If an iron casting, made out of the right kind of pig iron, be heated to a red heat in an iron box surrounded by some carbonaceous material for from 12 to 24 hours, the surface of the material becomes converted into a form of steel. The casting then has lost its extreme brittleness, and becomes more or less malleable. The castings are generally embedded in red hæmatite." In view of this statement, it is of interest to note that later on (p. 229), in dealing with case-hardening, the author shows that his knowledge is sound, as regards both the process and the changes which take place during the progress of case-hardening. Despite blemishes of this kind, the young engineering student will find much that is instructive and of interest in the book.

Science and War: The Rede Lecture, 1919. By the Rt. Hon. Lord Moulton. Pp. 59. (Cambridge: At the University Press, 1919.) Price 2*s.* 6*d.* net.

LORD MOULTON'S lecture gives a striking picture of the manner in which the methods of warfare have been transformed by the application to military purposes of the results of the rapid growth of chemical and physical knowledge and the advances in engineering and medical science during the last half-century. Not unnaturally, a considerable part of the discourse is devoted to the subject of explosives, on which the lecturer can speak with special authority, and the warning which he gives as to the importance of establishing the manufacture of nitric acid from atmospheric nitrogen in this country is one that deserves serious attention. Lord Moulton's final conclusion is that man, "endowed with all the powers that science has given him, will be self-destructive unless his social instincts . . . become sufficiently strong to induce him voluntarily to submit to those powers being fettered." "It is easy to criticise the League of Nations, but let us never forget that some combined action of that type is necessary."

LETTERS TO THE EDITOR.

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Progress of the Natural History Museum.

THE admirable survey of scientific progress published in the jubilee number of NATURE on November 6 has received the most cordial appreciation of your numerous readers. May I be allowed to direct attention to one or two omissions, without being supposed to dissociate myself from the universal chorus of approval?

The removal of the natural history collections of the British Museum from Bloomsbury and the increase in their importance afterwards are events which deserve notice, even though the South Kensington branch of the museum was perhaps omitted from your survey on the ground that it was a new home for existing collections, and not an institution which originated during the period under review. The actual removal took place in 1882–83, and the years which have followed have been marked by an extraordinary growth in the collections, associated with a record of scientific research which is equally remarkable. It must not be forgotten that the accurate discrimination of the species of animals, plants, and minerals is a fundamental part of the respective sciences. Even though the philosophical biologist is sometimes inclined to underrate the work of the systematist, he is frequently obliged to turn to him for information with regard to the facts from which he derives his results. The far-reaching conclusions which are based on the study of geographical distribution lose their value if they depend on erroneous determinations of species, while the study of evolution is equally dependent on the labours of the systematist. In bringing together an unrivalled collection of specimens and in publishing a notable series of memoirs dealing with it, the naturalists of the British Museum have taken their full share in the scientific progress of the last fifty years.

The number of specimens in the department of zoology (including entomology), omitting those regarded as duplicates, has been estimated as having been about 1,400,000 at the time of the removal to South Kensington in 1882–83. Successive estimates have been 2,245,000 in 1895, 3,060,000 in 1904, 5,960,000 in 1917, and about 6,000,000 at the time of writing. The other departments of the museum have also increased at a rapid rate. Thousands of forms new to science have been described, and the type-specimens are preserved in the collection. In spite of the magnitude of the task, the specimens have been arranged so carefully that most of them can be found without difficulty when they are required for study.

In addition to this side of its activities, the museum has done much for scientific education by the way in which a part of its treasures have been exhibited in the public galleries. The requirements of visitors who are principally interested in the systematic arrangement of natural history objects are amply provided for; and, to take a single instance, the exhibited series of large mammals is not equalled in any other museum. Other exhibits of a more general nature are shown in the central hall, where may be seen illustrations of the principal types of structure found in the several classes of vertebrates, inaugurated by the late Sir W. H. Flower, a former Director; a series of cases containing objects bearing on the theory of evolution; models and specimens of insects and Arachnids instrumental in carrying diseases; and other exhibits of general interest. The evolution of animals, as illustrated by their geological history, can be studied in the palæontological galleries, and particular attention may be directed to the series of elephants and their presumed ancestors to be found among the treasures of the gallery of fossil mammals. The series of nesting-birds and eggs, arranged on a system which was itself a new departure, deserves special mention. Attention may also be directed to the great development of the collection of domesticated animals, and to the wonderful series of specimens in the mineral gallery.

In noting the progress of the Natural History Museum it is appropriate to refer to the fundamental alteration which has taken place during the last fifty years in the conception of the functions of museums in general. It is now admitted that the museum is a place which ought to exercise an educational influence, and there is an increasing desire to arrange the exhibits in such a way as to teach some definite lesson. It has, moreover, been recognised that the biological sciences are of great economic importance, as is shown, for instance, by the extraordinary advances which have been made in preventive medicine by the discovery that the parasitic organisms giving rise to certain diseases are transmitted by blood-sucking animals. In this field of research the work of the systematic zoologist is of special importance, since it is essential to be able to distinguish the species of insect or other carrier of the pathogenic organism from its near allies which are harmless in this respect. In dealing with economic questions of this kind, and of many others, the Natural History Museum has done its full share, and its function as a consultative body capable of giving valuable information on matters of practical moment has become an important side of its activities.

The action of the then Secretary of State for the Colonies in calling a meeting in 1900 for placing entomological research in our tropical Possessions in Africa on a proper basis is an event which ought not to pass unrecorded. The immediate result was the establishment of the Entomological Research Committee (Tropical Africa), now the Imperial Bureau of Entomology. Short as its life has been at present, the Bureau has fully justified its existence, and it has become an important centre of research, the utility of which is cordially recognised in all parts of the Empire. It already possesses a wide influence, and it may fairly be anticipated that it will become increasingly important in promoting researches tending to reduce the ravages of sleeping sickness, malaria, and many other diseases which have taken a heavy toll of the life of man and domesticated animals in the past. The Trustees of the British Museum associated themselves from the first with this new departure, and provided such accommodation at the Natural History Museum as they were able to spare for the Director of the Bureau and a part of his staff.

May I, in conclusion, direct attention to another side of biological activity which deserves notice? The foundation of the Marine Biological Association in 1884 led to the erection of the Plymouth Laboratory, which has had a most successful career, in spite of the difficulties due to insufficient funds, in promoting the study of marine biology, including practical questions of great importance connected with the fishing industry. Although not the first institution of this kind to be founded in this country, the Plymouth Laboratory, with those on the Clyde, in the Isle of Man, and at St. Andrews and Cullercoats, has become an indispensable part of the biological equipment of Great Britain.

S. F. HARMER.

British Museum (Natural History),
November 17.

Gravitation and Light.

As I said last week (p. 334), and also in the December *Phil. Mag.* (p. 737), the refractivity $\mu-1$, necessary at every point of a gravitational field to produce the Einstein deflection, is the ratio of the energy of a constant-mass particle fallen there from infinity to the energy of the same particle moving with the speed of light; but it is not permissible to say that the solar gravitational field acts like a lens, for it has no focal length. If the sun were backed by a nebula or any luminous area, the light grazing the rim all round would be brought to a focus at a place seventeen times the distance of Neptune, while light from any larger circle would focus still further off in proportion to the area of the circle. So from a uniformly luminous area there would result a focal *line* of constant brightness. The moon is, unfortunately, impotent to make an annular eclipse interesting.

For an extended solar atmosphere to produce the deflection, its density would have to vary with the inverse distance, which seems unlikely; but this is just the way in which an æther tension ought to vary in order to cause gravitation—as Newton knew. The extra æther-tension factor, μ^2-1, would be twice the refractivity.

Possibly the concluding sentence in the *Phil. Mag.* article above referred to is not expressed with sufficient clearness. Permit me to explain my points thus:—

(1) The quasi-elasticity of æther—the property which enables it to transmit light and to effect electrical discharge—is probably due to exceedingly fine-grained constitutional vorticity with high-speed circulation, as argued in my book "The Ether of Space." Consequently it would have facility for gyrostatic action, yielding a perpendicular result to an acting force.

(2) That a gravitational force acting obliquely on light would probably be unable to alter speed, but, through the co-operation of its transverse and longitudinal components, it might be expected to produce an extra dose of deflection—assuming light to be subject to gravitation, as Newton surmised. So that by the time a beam of light coming from infinity had arrived at its nearest point to the sun, it would already have been deflected as much as an ordinary heavy particle would be deflected along its whole course.

I am aware that these are only suggestions for working out.

Einstein's equations, based on the impossibility of observing motion through æther, seem powerful instruments for extracting results; just as more familiar equations, based on the impossibility of "perpetual motion," have proved themselves effective; but neither set of equations explains, nor attempts to explain, the mechanism of the consequences they deduce. Dynamics have served us so well in the past that it must be still legitimate to try, wherever possible, to apply well-established principles to new phenomena. OLIVER J. LODGE.

Edgbaston, Birmingham, November 30.

The Displacement of Light Rays Passing near the Sun.

THE part of the earth's atmosphere within the conical shadow of the moon during a total solar eclipse may be regarded as approximately a right circular cylinder, the area of the base of which depends on the length of the shadow. Observations have shown that there are temperature and pressure gradients in this cylinder. The latter gradient at the surface of the earth is usually slight, but the temperature gradient may be considerable, so that, assuming that there is equilibrium, we have, roughly speaking, a cylinder of air the density of which decreases outwards in all directions perpendicular to its axis. When we remember that the light from stars at small angular distances from the sun's centre makes small angles with the axis of this cylinder, it is easy to see that a very small density gradient would be sufficient to account for the displacements that were observed in the total solar eclipse of the present year.

Suppose the cylinder to be made up of two parts, an inner and an outer, the common boundary being a coaxial cylinder, and let a ray of light in the outer portion inclined at a small angle α to the axis fall on the boundary, the deviation δ is given by

$$\cos\alpha=\mu\cos(\alpha+\delta),$$

where μ is the index of refraction for rays passing from the outer portion to the inner.

Since δ is very small in comparison with α, we have, approximately,

$$\delta=\frac{\mu-1}{\mu\tan\alpha}=\frac{\mu-1}{\tan\alpha}\text{ very nearly,}$$

since μ does not differ much from unity.

If $\alpha=30'$ and $\delta=1{\cdot}7''$, we get

$$\mu=1+\delta\tan\alpha,$$

δ being expressed in circular measure.

Thus $\mu=1{\cdot}00000007$, and for small values of α it is clear that δ is inversely proportional to the angular distance of the star from the centre of the sun's disc.

If we take μ_1, the absolute index of refraction of the outer portion, to be 1·0003, μ_2, the absolute index of refraction of the inner portion, will be 1·00030007, and consequently

$$\frac{\mu_2-1}{\mu_1-1}=1{\cdot}0002,$$

which will be the ratio of the density of the air in the inside portion to the density of the air in the outside portion. On the assumption that there is no gradient of pressure, this would imply a difference of temperature of about 1/18° C., a very small amount when it is remembered that the lowering of temperature at the surface of the earth during an eclipse may be as much as 5° C.

In the actual case the path of a ray will be a curve, but the above remarks will serve to show that the density gradient would probably be sufficient to produce the observed effect. It is clear, too, that the displacement in the actual case will be inversely proportional to the angular distance of the star from the sun's centre, and that it will depend on local conditions, so that the amount of displacement will be different for different places.

I think it is quite likely that if the refraction of the atmosphere of the earth due to density changes during an eclipse could be accurately obtained and allowed for, it would be found that there is no Einstein effect at all. ALEXR. ANDERSON.

University College, Galway.

EINSTEIN'S RELATIVITY THEORY OF GRAVITATION.

I.

THE results of the Solar Eclipse Expeditions announced at the joint meeting of the Royal Society and Royal Astronomical Society on November 6 brought for the first time to the notice of the general public the consummation of Einstein's new theory of gravitation. The theory was already in being before the war; it is one of the few pieces of pure scientific knowledge which have not been set aside in the emergency; pre-

parations for this expedition were in progress before the war had ceased.

Before attempting to understand the theory which, if we are to believe the daily Press, has dimmed the fame of Newton, it may be worth while to recall what it was that he did. It was not so much that he, first among men, used the differential calculus. That claim was disputed by Leibniz. Nor did he first conceive the exact relations of inertia and force. Of these, Galileo certainly had an inkling. Kepler, long before, had a vague suspicion of a universal gravitation, and the law of the inverse square had, at any rate, been mooted by Hooke before the "Principia" saw the light. The outstanding feature of Newton's work was that it drew together so many loose threads. It unified phenomena so diverse as the planetary motions, exactly described by Kepler, the everyday facts of falling bodies, the rise and fall of the tides, the top-like motion of the earth's axis, besides many minor irregularities in lunar and planetary motions. With all these drawn into such a simple scheme as the three laws of motion combined with the compact law of the inverse square, it is no wonder that flights of speculation ceased for a time. The universe seemed simple and satisfying. For a century at least there was little to do but formal development of Newton's dynamics. In the mid-eighteenth century Maupertuis hinted at a new physical doctrine. He was not content to think of the universe as a great clock the wheels of which turned inevitably and irrevocably according to a fixed rule. Surely there must be some purpose, some divine economy in all its motions. So he propounded a principle of least action. But it soon appeared that this was only Newton's laws in a new guise; and so the eighteenth century closed.

The nineteenth saw great changes. When it closed, the age of electricity had come. Men were peering into the secrets of the atom. Space was no longer a mighty vacuum in the cold emptiness of which rolled the planets. It was filled in every part with restless energy. Æther, not matter, was the last reality. Mass and matter were electrical at bottom. A great problem was set for the present generation: to reconcile one with the other the new laws of electricity and the classical dynamics of Newton. At this point the principle of least action began to assume greater importance; for the old and the new schemes of the universe had this in common, that in each of them the time average of the difference between the kinetic and the potential energies appears to be a minimum.

One of the main difficulties encountered by the electrical theory of matter has been the obstinate refusal of gravitation to come within its scope. Quietly obeying the law of the inverse square, it heeded not the bustle and excitement of the new physics of the atom, but remained, independent and inevitable, a constant challenge to rash claimants to the key of the universe. The electrical theory seemed on the way to explain every property of matter yet known, except the one most universal of them all. It could trace to its origins the difference between copper and glass, but not the common fact of their weight; and now the æther began silently to steal away.

One matter that has seriously troubled men in Newton's picture of the universe is its failure to accord with the philosophic doctrine of the relativity of space and time. The vital quantity in dynamics is the acceleration, the change of motion of a body. This does not mean that Newton assumed the existence of some ultimate framework in space relative to which the actual velocity of a body can be uniquely specified, for no difference is made to his laws if any arbitrary constant velocity is added to the velocity of every particle of matter at all time. The serious matter is that the laws cannot possibly have the same simplicity of form relative to two frameworks of which one is in rotation or non-uniform motion relative to the other. It seems, for instance, that if Newton were right, the term "fixed direction" in space means something, but "fixed position" means nothing. It seems as if the two must stand or fall together. And yet the physical relations certainly make a distinction. Why this should be so has not yet been made known to us. Whatever new theory we adopt must take account of the fact.

It was with some feeling of relief that men hailed the advent of the æther as a substitute for empty space, though we may note in passing that some philosophers—Comte, for example—have held that the concept of an æther, infinite and intangible, is as illogical as that of an absolute space. But, jumping at the notion, physicists proposed to measure all velocities and rotations relative to it. Alas! the æther refused to disclose the measurements. Explanations were soon forthcoming to account for its reluctance; but these were so far-reaching that they explained away the æther itself in the sense in which it was commonly understood. At any rate, they proved that this creature of the scientific imagination was not one, but many. It quite failed to satisfy the cravings for a permanent standard against which motion might be measured. The problem was left exactly where it was before. This was pre-war relativity, summarised by Einstein in 1905. The physicists complained loudly that he was taking away their æther.

Let it not be thought, however, that the results of the hypothesis then advanced were purely negative. They showed quite clearly that many current ideas must be modified, and in what direction this must be done. Most notably it emphasised the fact that inertia is not a fundamental and invariable property of matter; rather it must be supposed that it is consequent upon the property of energy. And, again, energy is a relative term. One absolute quantity alone remained; one only stood independent of the taste or fancy of the observer, and that was "action." While the æther and the associated system of measurement could be selected as any one of a legion, the principle of least action was satisfied in each of them, and the magnitude of the action was the same in all.

But, still, gravitation had to be left out; and the question from which Einstein began the great advance now consummated in success was this. If energy and inertia are inseparable, may not gravitation, too, be rooted in energy? If the energy in a beam of light has momentum, may it not also have weight?

The mere thought was revolutionary, crude though it be. For if at all possible it means reconsidering the hypothesis of the constancy and universality of the velocity of light. This hypothesis was essential to the yet infant principle of relativity. But if called in question, if the velocity of light is only approximately constant because of our ordinary ways of measuring, the principle of relativity, general as it is, becomes itself an approximation. But to what? It can only be to something more general still. Is it possible to maintain anything at all of the principle with that essential limitation removed?

Here was exactly the point at which philosophers had criticised the original work of Einstein. For the physicist it did too much. For the philosopher it was not nearly drastic enough. He asked for an out-and-out relativity of space and time. He would have it that there is no ultimate criterion of the equality of space intervals or time intervals, save complete coincidence. All that is asked is that the order in which an observer perceives occurrences to happen and objects to be arranged shall not be disturbed. Subject to this, any way of measuring will do. The globe may be mapped on a Mercator projection, a gnomonic, a stereographic, or any other projection; but no one can say that one is a truer map than another. Each is a safe guide to the mariner or the aviator. So there are many ways of mapping out the sequences of events in space and time, all of which are equally true pictures and equally faithful servants.

This, then, was the mathematical problem presented to Einstein and solved. The pure mathematics required was already in existence. An absolute differential calculus, the theory of differential invariants, was already known. In pages of pure mathematics that the majority must always take as read, Riemann, Christoffel, Ricci, and Levi-Civita supplied him with the necessary machinery. It remained out of their equations and expressions to select some which had the nearest kinship to those of mathematical physics and to see what could be done with them. E. CUNNINGHAM.

DISCOVERY OF A MINOAN PALACE AT MALIA, IN CRETE.

DISCOVERIES of great importance have been made during the course of excavations carried out this year in Crete by M. Joseph Hatzidakis, at a site one kilometre from the shore, near the village of Malia, about twenty miles east of Candia.

The site of a palace of the Middle Minoan epoch has been uncovered, and numerous objects found. The containing walls of the palace, the lower courses of which consist of *poros* stone, can all be traced, the dimensions of the building being 110 metres in length and 80 metres in width. The interior walls, which are of bricks and rubble, are 2·30 metres in thickness, and the floor of the palace is composed of a layer of white earth upon which is a stratum of chalk and sand with a top surface of red chalk paste. The outside of the containing walls was covered with a white chalk wash.

The palace was destroyed by fire shortly after the end of the Middle Minoan epoch, and probably suffered from the depredations of looters for a considerable time after its destruction. In consequence, few objects of value, and nothing intact, have so far been discovered. A very large number of small fragments of gold leaf, however, have been found. For many years past similar fragments have been found by the peasants from time to time, and the site became known as "Chrysolakkos," "The ditch of gold." Capt. Spratt early last century noted the prevalence of such gold fragments on this site. The fragments are derived in all probability from some large bone or wooden objects which were decorated with gold leaf. Bronze was rare, only a dagger blade, a brooch, and a band having been found.

The fields between the shore and the palace show traces of walls, and in one case a complete house, all of the same date as the palace, and clearly belonging to the town in which the palace was situated. The site of a necropolis was found near the shore, where one grave containing pottery of the same date as the palace was opened.

Minoan pictographic or graphic signs were found cut on various stone blocks in the palace. The double-axe occurred on a large tetragonal pillar, which was of the type found at Knossos, but twice the size. A six-rayed star of a known type also occurred; a similar star with a spray at the end of one of the rays represents a sign not hitherto known.

The pottery so far discovered is disappointing, no complete or even well-preserved pieces having been found. The best fragments, mostly of cups of the Middle Minoan periods, were found in what appears to have been a shrine.

Three kilometres to the west of the palace a number of graves of the third Late Minoan or Mycenean period were found. One of these graves was opened, and was found to contain five rectangular "larnakes," in each of which was a skeleton.

The importance of the site lies in the fact that this is the only example hitherto found of a palace of the Middle Minoan epoch without an overlying building of later date. The Middle Minoan parts of the palaces of Phæstos and Knossos are overbuilt with walls of the Late Minoan periods, and the plans and details of the Middle Minoan palaces at these places cannot, in consequence, be definitely ascertained. The existence of a city and necropolis of the same date as the palace increases the importance of the site. The Late Minoan city is clearly to be found some distance away. The excavations will be continued, and promise important results.

NOTES.

THE desirability of fostering scientific research as a result of experience gained during the war was recently urged upon various Government Departments by the British Association. There is reason to believe that measures are being taken to this end in various directions; in particular, the association has received from the Admiralty a communication in the course of which it is stated that the authorities there "are keenly alive to the supreme importance of research in its bearing on naval requirements, and that the organisation of suitable arrangements for this purpose is now engaging, and will continue to engage, their earnest attention. Rapid progress is now being made in the elaboration of a complete scheme which will provide, on one hand, for systematic and continuous development in research and experimental establishments controlled by the Department, and, on the other, for an effective relation between these establishments and scientific institutions throughout the country."

THE collection of precious stones which was formed by the late Sir Arthur H. Church, and presented by his widow to the Trustees of the British Museum, has recently been placed in a special case under the archway leading from the main gallery of minerals to the meteorites pavilion at the Natural History Museum. Sir Arthur Church was for thirty-two years professor of chemistry at the Royal Academy of Arts, and his leaning towards art led him from his early days to take an interest in rare gem-stones. In consequence, the collection was at his death exceptionally rich in specimens of mineral species seldom seen in ordinary jewelry, as well as in unusual specimens of familiar species. The pride of the collection is the brilliant orange-coloured spessartite, which is all but unique, since only one other such stone (cut, in fact, from the same original crystal) is known to exist. The collection is very rich in zircons. Together with the four stones which Sir Arthur Church presented in his lifetime, the collection numbers 207 specimens, without counting the eight diamond points and the twenty-one diamond brilliants used in the setting of a zircon and a peridot ring respectively; of them, 170 are set in 162 gold rings and 37 are unset.

DR. O. HOLTEDAHL is organising a Norwegian exploring expedition to Novaya Zemlya, and hopes to sail in June next year. Dr. Holtedahl, who has had previous polar experience in geological exploration in Spitsbergen, has laid his plans before the Norwegian Academy of Sciences, where they obtained the support of Dr. F. Nansen, who advocated a State grant. According to the *Morning Post*, Dr. Holtedahl will make the base of his expedition on Matochkin Shar, the strait between the two large islands, where there is a small Samoyede settlement. A botanist, a zoologist, and a meteorologist will accompany the expedition, while the leader will devote his time to geology and geophysical problems. Novaya Zemlya is by no means a *terra incognita*; Russian explorers have frequently visited it, particularly in search of minerals. But the results of their work have only partly been published, and the collections and observations have probably been destroyed. In 1916 the Russian Government proposed to erect two permanent meteorological stations in Novaya Zemlya, one at the north end and the other at Matochkin Shar; but nothing has yet been done. Dr. Holtedahl rightly insists on the usefulness of a permanent station. He would also like to see one on the island of Jan Mayen, between Iceland and Spitsbergen.

A LETTER has been received by us from Dr. Th. Mortensen, the distinguished curator of the zoological collections in the Royal Museum, Copenhagen, protesting against the use of the German word "Anlage" in zoological papers written in English. It is rather curious that it should have been left to a friendly neutral to protest against this disfigurement of the English language. Dr. Mortensen suggests that the English word "rudiment" conveys exactly the meaning of "Anlage," and he hazards the supposition that the reason why "rudiment" is not more largely used in this sense is that it has been customary in the past to employ the phrase "rudimentary organ" to signify the disappearing remnant of a once functional structure. In both his views we heartily concur with Dr. Mortensen. Unfortunately, the phrase "rudimentary organ" is found embedded in our great classic of biology, the "Origin of Species," and it is probably for this reason that some years ago leading American zoologists, who disliked the word "Anlage," attempted to replace it by the English word "fundament," an attempt which excited only amusement in the zoological world in general. To us it seems that only a little perseverance is required in order to establish the word "rudiment" as the English equivalent of "Anlage," whilst the equally good English word "vestige" can be used to signify the remnant of a disappearing organ. This usage has already been adopted by some of our most recent writers on embryology, and it is to be hoped that it will spread until it becomes universally recognised.

THE appeal which is being made by the Research Institute in Dairying, attached to University College, Reading, for funds to purchase a suitable farm and to provide research laboratories and a dairy is deserving of support, not only by those connected with the dairying industry, but also by the public at large. A good supply of pure milk at a moderate price is most important for the nation, and it is only by a systematic inquiry conducted with proper equipment by skilled workers that the problem will be solved. The formation of a research institute on dairying dates only from 1912, and, naturally, the work which has been undertaken up to the present has been seriously handicapped by war conditions. Now, however, the staff of the institute is in a position to press forward the various inquiries which have in many cases already been commenced. An excellent start was made with an investigation of the causes which lead annually to heavy losses when milk sours prematurely. As would be expected, cleanliness and a low temperature have been proved to be the chief agents in the prevention of these avoidable losses. The reports already issued from the institute give some very striking illustrations of the high "keeping" properties of clean milk. In cheese-making the Research Institute has also a most promising field of investigation, for although many of the best varieties of cheese in the world have had their origin in this country, very little is known of the details of the processes. The higher price of milk makes it imperative that there should be no avoidable losses either in the milk supply or in the articles made from milk, the high food value (to say nothing of the physiological value) of which is now so generally recognised.

THE death has occurred, at the age of sixty-nine, of Dr. John Vose Hazen, who had recently resigned the chair of civil engineering and graphics at Dartmouth College, New Hampshire, after a long tenure.

DR. W. G. BISSELL, whose death is reported in his fiftieth year, had been chief of the Bureau of Bacteriology in the city of Buffalo since 1894. He was

president of the New York State Sanitary Officers' Association.

AT the ordinary scientific meeting of the Chemical Society to be held on Thursday, December 18, Prof. J. Walker will deliver a lecture entitled "War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes."

DR. PAUL SABATIER (Toulouse), Dr. Pierre Paul Emile Roux (Paris), Dr. Jacques Loeb (New York), Dr. Robert Andrews Millikan (Chicago), Dr. Arthur Gordon Webster (Harvard), and Dr. William Wallace Campbell (California) have been elected honorary members of the Royal Institution.

THE death is announced, in his eighty-fourth year, of Dr. Charles Henry Hitchcock, professor of geology at Dartmouth College, U.S.A., from 1868 to 1908. Dr. Hitchcock was widely known as the compiler of several geological maps of the United States, and for his researches in ichnology, geology of the crystalline schists, and glacial geology. During the winter of 1870–71 he established, on the top of Mount Washington, the first high mountain observatory in the United States. Among his many publications were memoirs upon the fossil tracks of the Connecticut Valley. On his retirement he went to live in Hawaii (where he died), and in 1909 he published a book on the volcanoes of that territory.

THE following are among the lecture arrangements at the Royal Institution before Easter, 1920:—Prof. W. H. Bragg, six lectures adapted to a juvenile auditory on The World of Sound; Sir John Cadman, two lectures on (1) Modern Development of the Miner's Safety Lamp and (2) Petroleum and the War; Prof. G. Elliot Smith, three lectures on The Evolution of Man and the Early History of Civilisation; Prof. Ernest Wilson, two lectures on Magnetic Susceptibility; Prof. Arthur Keith, four lectures on British Ethnology: The Invaders of England; Prof. A. E. Conrady, two lectures on Recent Progress in Photography; Prof. A. H. Smith, two lectures on Illustrations of Ancient Greek and Roman Life in the British Museum; Lt.-Col. E. Gold, two lectures on The Upper Air; Sir F. W. Dyson, Astronomer Royal, three lectures on The Astronomical Evidence bearing on Einstein's Theory of Gravitation; and Sir J. J. Thomson, six lectures on Positive Rays. The Friday evening discourses will begin on Friday, January 16, 1920, at 9 o'clock, when Sir James Dewar will deliver a discourse on Low-temperature Studies. Succeeding discourses will probably be given by Sir C. A. Parsons, Mr. S. G. Brown, Prof. W. M. Bayliss, Dr. E. J. Russell, Mr. W. B. Hardy, the Hon. J. W. Fortescue, Prof. J. A. Fleming, Mr. E. McCurdy, Sir J. J. Thomson, and others.

WE learn with regret of the death on November 25 of Mr. Frederick Webb Headley, at the age of sixty-three years. Educated at Harrow and Caius College, Cambridge, where he obtained a First Class in the Classical Tripos, Mr. Headley spent nearly forty years of his life as an assistant master at Haileybury College, where, so recently as June 30 last, he delivered his last lecture to the College Natural History Society on his favourite subject, "The Pedigree and Life of Birds." Through the instrumentality of this society and of the museum he succeeded in maintaining, generation after generation, a body of active boy-naturalists in the college, and few men were better able to fan into enthusiasm the spark of what so often proves but the passing hobby of a young boy. Of Headley's published works two, namely, "The Structure and Life of Birds" and "Life and Evolution," are very largely the finished product of lectures delivered to the boys. The variety of subjects handled is eloquent testimony to the wide sympathy and biological knowledge of the man—a classic by early training. The doctrine of evolution made a powerful appeal to his mind, as is evidenced by his "Problems of Evolution" and by "Darwinism and Modern Socialism." But it was "birds" and "flight" that more than all else attracted him. The war prevented the execution of a projected tour abroad with "birds" as a main object, and kept him at Haileybury longer than he had intended. Another such tour was planned after his final retirement last July. *Dis aliter visum.*

AT the meeting of the Illuminating Engineering Society on November 25, a short address on "Lambert and Photometry" was given by the president, Mr. A. P. Trotter, who raised the question whether Lambert ever devised a photometer, inclining, however, to the view that Bouguer was the first to contrive an apparatus for measuring light. Later in the evening Mr. Haydn T. Harrison exhibited a new form of photometer which had several interesting features, notably the use of an illuminated scale. The greater part of the evening was given up to exhibits, including a new form of "daylight" or colour-matching lamp, shown by Mr. L. C. Martin. This device, which is due to Mr. Sheringham, the well-known artist, involves the projection upwards of light from an electric lamp to a surface carrying a chessboard pattern in various colours. The reflected light closely resembles daylight in colour, and is stated to be well adapted to colour-matching processes. The indirect method thus utilised is considered very suitable for use in picture galleries, etc. Other exhibits included a series of tungsten arc ("pointolite") lamps exhibited by Mr. P. Freedman, of the Ediswan laboratory. This form of lamp utilises an arc between tungsten electrodes within a hermetically sealed bulb, and has proved very suitable for optical projection. By improved methods of manufacture larger tungsten globules, facilitating much higher candle-powers, have been prepared. Lamps giving up to 1000 c.p. have already been used, and a special 4000-c.p. unit, which it is hoped will prove specially suitable for kinema work, was shown at the meeting.

THE retirement of Dr. Cecil Lyster from the position of head of the electro-therapeutic department of the Middlesex Hospital was announced at a meeting of the governors of the hospital. The chairman, Lord Athlone, said that Dr. Lyster was now lying in a critical condition directly due to his self-sacrificing devotion to duty. Dr. Lyster was one of the pioneers of scientific research, and applied himself to the study of X-rays and radium and their use in the treatment of disease, especially cancer. By exposure to the rays in the early days he fell a victim to the disease he sought to conquer. Though suffering, he declined to be set aside from his purpose, and continued his good work until now, when work for a time was no longer possible. Mr. Sampson Handley spoke of the high esteem in which Dr. Lyster was held by his colleagues on the staff of the hospital. Dr. Lyster was president of the section of electro-therapeutics of the Royal Society of Medicine for the year which ended in October last. His colleagues in the domain of X-rays and electro-therapeutics had occasion to appreciate his invariable tact and sympathy at the meetings over which he presided. At the joint meeting of his section with the Institution of Electrical Engineers on March 21 last he remarked, in introducing the president of the institution and asking him to take the chair: "We are amateurs in electricity, and we are at last asking the professional electrician to tell

us what we want. I hope meetings of this sort will be continued in years to come, and that we shall be able to interest the Institution of Electrical Engineers in our work as electro-therapeutists and radiologists. It is a fascinating subject, and a far-reaching one for humanity—that is, the future of the electrical and radiological treatment of disease Perhaps my optimism is enormous." It is this spirit of optimism that has buoyed up Dr. Lyster through his times of suffering, and caused him to remain at his post to the last.

DR. J. WALTER FEWKES, Chief of the Bureau of American Ethnology, has recently returned from two months' field-work on the Mesa Verde National Park, Colorado. This park is the only one reserved by the U.S. Government for the protection of aboriginal buildings, and for the last decade the Department of the Interior and the Smithsonian Institution have co-operated in the excavation and repair of ruins in order that they may be preserved for posterity, after having been put in a condition to show their structural features. The field-work of last summer was devoted to a cliff-dwelling called Square Tower House from a high tower situated midway in its length. This tower is 40 ft. high, and is the highest building constructed of masonry by Indians north of Mexico before the coming of the whites. It adds to this unique feature the best-known example of prehistoric masonry, shown in the construction of the roofs of two circular rooms. The original rafters are still in place, showing the marks of stone implements used by the builders. The whole ruin, which measures 136 ft. in length, is most picturesquely situated, and has already become one of the greatest attractions of the park. An unexpected result of the field-work was the discovery of many inconspicuous buildings among the cedars on top of the plateau. The evidences of these buildings before excavating were very obscure, but they are so numerous in certain areas that there is scarcely a square quarter-mile in which one of them does not occur. One of these small buildings when excavated was found to belong to a very ancient type, probably the oldest on the mesa.

WE have received the second number of *Medical Science*, a monthly periodical of abstracts and reviews of medical science published by the Medical Research Committee. The present issue contains, among others, reviews on diphtheria, tuberculosis, gastric ulceration, influenza, and cerebro-spinal fever. In the last-named, Dr. Rolleston surveys the epidemiology, symptoms, and treatment of the disease, particularly with serum. This, in the hands of numerous observers, has proved to be of benefit, reducing the mortality provided it is administered early enough.

A SHORT, but very welcome, account of the courtship of the dabchick, by Mr. Julian Huxley, appears in *British Birds* for November. The author was too late to witness the earlier phases of the courtship, but he contrived to glean much information as to their behaviour after pairing-up had taken place. These birds, lacking the frills and crests characteristic of other species of grebes, display none of the posturing which takes place in the more resplendent species, but content themselves with the performance of duets recalling the neighing of a horse. They also spend much time in long excursions on the water, swimming side by side. It is to be hoped that next year it will be possible to start observations earlier in order that the initial stages of the courtship may be studied. Mr. Huxley's studies on the courtship of the great crested grebe are known to all ornithologists, and his able handling of this theme makes us the more anxious to have the complementary picture.

IN an important memoir on a new type of nephridium found in Indian earthworms of the genus Pheretima (*Quarterly Journal of Microscopical Science*, vol. lxiv., part 1) Mr. Karm Narayan Bahl gives a very interesting description of the excretory system of *Pheretima posthuma*. He finds three distinct kinds of nephridia in this worm: septal, pharyngeal, and integumentary. Although the nephridia are very numerous and all small (micronephridia), the system is not plectonephric, each nephridium being a separate organ. The chief novelty of the author's work lies in the discovery that the septal nephridia open into the intestine, instead of on to the surface of the body, by segmentally arranged apertures, not directly, but through a system of ducts, of which the most important are a pair of longitudinal excretory canals lying above the intestine, one on each side of the mid-dorsal line. The author applies the term "enteronephric" to this remarkable type of nephridial system, and puts forward the suggestion—due to Prof. W. N. F. Woodland—that the discharge of the excretory products into the intestine may be a special adaptation for the conservation of moisture in a dry climate.

THE *Journal of the Board of Agriculture* for October contains a preliminary report on the recent Lincoln tractor trials. The excellent work done by the machines and the large attendance of farmers show that the industry has now passed the pioneer stage. The tendency of the manufacturers is less to novelty of design than to development in accordance with the experience obtained in this country, chiefly as the result of the operation of the Government tractor scheme. Close attention is being paid to the reduction of weight, to the increased accessibility of the vital parts of the machinery, and to the provision of protection from the effect of weather and dirt. Interesting comparisons were made of the ploughing done by tractors fitted respectively with high-speed vertical and low-speed horizontal engines, with wheels and caterpillar-tracks, and between self-contained machines and independent tractors. The use of the tractor is not restricted to ploughing, and there were important haulage tests and threshing demonstrations. Great as is the value of the present trials from the commercial and educational points of view, further trials extending over a considerable interval, and giving greater uniformity of task and conditions, will be necessary before the capacity of the various machines can be defined.

THE *Kew Bulletin* (Nos. 6 and 7, 1919) contains an account of recent investigations by J. Bintner on the symptoms and distribution of silver-leaf disease. There has been much controversy as to the cause of the disease, which is now established as mainly due to the growth in the tissues of the mycelium of the fungus *Stereum purpureum*. Mr Bintner demonstrates the presence of the fungus in the wood of diseased branches, which show the brown coloration beneath the bark characteristic of the disease. No trace of the fungus has been found in the leaves, and it is suggested that the separation of the cells, which gives the silver effect, is caused by the production of some diffusible toxin by the fungus, which is conveyed to the leaves in the water-conducting channels. Infection takes place through open wounds above ground and immediately below ground-level, and inoculation experiments confirm the view that injured superficial roots can be infected. Localised silvering of a branch results from local infection which has not yet spread to the main stem, and excision of the diseased branch may save the tree. On the other hand, silvered suckers springing from a healthy tree indicate root-infection, and where root or stem is

infected there is no hope of saving the tree. The disease has been proved to occur on a number of plants besides plum, apple, and other members of the family Rosaceæ, including species of laburnum, horse-chestnut, and cultivated varieties of gooseberries and currants. As a preventive measure good cultivation is recommended; careless pruning, unsatisfactory drainage, and deficiency of lime are especially to be avoided. The author also indicates an apparently distinct disease which he calls "false silver-leaf," which may be mistaken for the disease caused by Stereum, but no trace of this fungus has been found in the plants affected. It is suggested that false silver-leaf, from which plants recover under careful treatment, is due to physiological weakness. It has been observed in cultivated varieties of apple, cherry, peach, and plum.

A NOTEWORTHY addition to our knowledge of Eocene foraminifera is made by the publication of the late Mr. E. Halkyard's "Fossil Foraminifera of the Blue Marl of the Côte des Basques, Biarritz," under the care of Messrs. E. Heron-Allen and A. Earland (Mem. Manchester Lit. and Phil. Soc., vol. lxii., part ii.). Megalospheric and microspheric forms are discussed among the nummulites.

MESSRS. F. F. GROUT and T. M. Broderick (*Amer. Journ. Sci.*, vol. xlviii., p. 199, 1919) describe structures in the Huronian iron-bearing strata of the Mesabie range in Minnesota as due to algæ. In this they have the support of Dr. C. Walcott, who writes that the iron-ore was evidently separated out of marine waters through the metabolism of the algal growths, which he compares with Cryptozoön.

IN the *American Journal of Science* (vol. xlviii., p. 136, 1919) Prof. R. A. Daly replies to recent criticisms of his "glacial-control" theory of the growth of coral-reefs. He urges that the general absence of cliffs on the island spurs may be due to the protection afforded by rapidly growing fringing reefs in late Cainozoic time; these would have to be scoured away before the Pleistocene sea could attack the volcanic masses. Variations in the depths of lagoons, again, may be expected even on a general platform of erosion, owing to the presence of drowned valleys, fault-troughs, and volcanically formed depressions not yet filled with detritus. Lagoon depths greater than 50 or 60 fathoms are, however, rare.

THE *Times* of November 28 contains an article from Prof. Einstein on his generalised principle of relativity. Prof. Einstein remarks at the beginning of the article: "After the lamentable breach in the former international relations existing among men of science, it is with joy and gratefulness that I accept this opportunity of communication with English astronomers and physicists. It was in accordance with the high and proud tradition of English science that English scientific men should have given their time and labour, and that English institutions should have provided the material means, to test a theory that had been completed and published in the country of their enemies in the midst of the war." After a brief account of the general nature of the theory, which does not add anything to what has been summarised by Prof. Eddington in his report to the Physical Society, Prof. Einstein concludes: "The great attraction of the theory is its logical consistency. If any deduction from it should prove untenable, it must be given up. A modification of it seems impossible without destruction of the whole. No one must think that Newton's great creation can be overthrown in any real sense by this or any other theory. His clear and wide ideas will for ever retain their significance as the foundation on which our modern conceptions of physics have been built. . . . By an application of the theory of relativity to the taste of readers, to-day in Germany I am called a German man of science, and in England I am represented as a Swiss Jew. If I come to be regarded as a *bête noire*, the descriptions will be reversed." Prof. Eddington, in the *Contemporary Review*, quotes from Newton's "Opticks":—"Query 1. Do not bodies act upon light at a distance, and by their action bend its rays?"

ON Engler's theory of the origin of petroleum, the oil has been formed out of animal and vegetable fatty matters derived from marine animals and plants. The fats have been hydrolysed by water, and the resulting fatty acids, under the influence of heat and pressure, have then been decomposed into carbon dioxide and hydrocarbons, these latter constituting the petroleum. Whilst this theory would account for the liquid hydrocarbons of the aliphatic series found in petroleum, it does not explain the presence either of solid paraffins or of the aromatic (naphthenic) hydrocarbons which are found in most petroleums, and, indeed, form the whole of some varieties. Engler's distillation experiments in confirmation of the theory were made chiefly on free oleic and stearic acids. It is probable, however, that salts of these acids, rather than the free acids themselves, would be the bodies acted upon during the natural production of petroleum. Following up this idea, MM. Pictet and Potok have carried out a series of experiments on the distillation of sodium stearate and sodium oleate, with the view of ascertaining whether, in operations thus approximating more closely to the natural conditions, aromatic hydrocarbons or paraffins of high boiling points are produced (*Helvetica Chimica Acta*, 2, v., 501). In the result it was found that the chief products were acyclic and unsaturated hydrocarbons closely agreeing with those found in American petroleum, but no trace of naphthenic (aromatic) hydrocarbons was produced. Hence the origin of Baku petroleum, and of the numerous other kinds which contain these naphthenic bodies, is not accounted for by Engler's theory. Further, since many of these bodies show optical rotation, they have probably been produced at relatively low temperatures, and not by the closing up of acyclic compounds, which would demand high temperatures and yield inactive products. No likely source of such optically active bodies suggests itself except the resinous or terpenic constituents of the higher plants. Similar compounds have, in fact, been extracted from coal. For the numerous petroleums containing both acyclic and naphthenic hydrocarbons a twofold origin appears to be indicated.

THE announcements of *Messrs. A. and C. Black, Ltd.*, include "X-rays in General Practice," Alice Vance Knox, with chapters on Instrumentation, Dr. R. Knox; "Cerebro-Spinal Fever: The Etiology, Symptomatology, Diagnosis, and Treatment of Epidemic Cerebro-Spinal Meningitis," Drs. C. Worster-Drought and A. M. Kennedy; "Medieval Medicine," J. J. Walsh; and "The Making of Europe: A Geographic Treatment of the Historic Development of Europe," W. H. Barker and W. Rees. In addition to the books announced for publication by the *Cambridge University Press* (see NATURE, November 20, p. 321) may be mentioned "Physics," Dr. Norman R. Campbell, 3 vols.; "The Theory of the Imaginary in Geometry," J. L. S. Hatton; "Practical Chemistry for Agricultural Students," H. A. D. Neville, vol. i.; "What Became of the Bones of St. Thomas," Rev. Canon A. J. Maron; "From Ritual to Romance" (A Study of Comparative Religion and

Folk-lore), Miss J. L. Weston. *Messrs. Constable and Co., Ltd.*, announce "Physiology and the Nation's Needs," edited by Prof. W. D. Halliburton, containing essays by Dr. M. S. Pembrey, Prof. D. Noël Paton, and the editor on, respectively, "Physical Training and the Open-air Life," "Physiology in the Study of Disease," and "Physiology and the Food Problem." They also promise "Elementary Plane Trigonometry," H. E. Piggott.

MESSRS. DULAU AND CO., LTD., 34 Margaret Street, W.1, have issued a Catalogue (No. 80) of nearly six hundred works on Diatomaceæ, Botany, Horticulture, Agriculture, Natural History, Geology, Palæontology, Voyages and Travels, Astronomy, Physics and Mechanics which will doubtless appeal to many readers of NATURE. It can be obtained upon application.

OUR ASTRONOMICAL COLUMN.

HELIOCENTRIC GROUPING OF PLANETS IN DECEMBER.—The astrologers have been amusing themselves and alarming the timid by predicting violent cosmic convulsions as the result of the planetary grouping on December 17. The actual position is sufficiently interesting to warrant a note. During the five days December 13 to 17, six of the eight major planets will be within a range of 26° in heliocentric longitude, while Uranus will be in the same line on the other side of the sun, the earth alone standing out. In the following list the two longitudes given refer to noon on December 13 and 17 respectively:—Mercury, 130° to 154°; Venus, 135° to 143°; Earth, 79° to 84°; Mars, 152° to 154°; Jupiter, 129°; Saturn, 155½°; Uranus, 331°; and Neptune, 130°. There were similar scares when the four giant planets were all near perihelion together. We may safely predict that they will be as baseless now as they were then.

COMETS.—Finlay's periodic comet passed perihelion about October 15·38. It was a fairly conspicuous object in November, and observations are numerous. It will be much fainter in December, but an ephemeris (for Greenwich midnight) may still be of use:—

		R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Dec.	5	1 33 59	13 14	Dec. 13	2 7 12	16 52
	7	1 43 7	14 20	15	2 14 13	17 28
	9	1 51 41	15 18	17	2 20 47	17 56
	11	1 59 42	16 9	19	2 26 56	18 17

Schaumasse's periodic comet is also fading, but more slowly. Ephemeris for Greenwich midnight:—

		R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Dec.	5	14 9 36	2 2	Dec. 13	14 33 13	3 52
	7	14 15 38	2 30	15	14 38 54	4 17
	9	14 21 35	2 58	17	14 44 31	4 42
	11	14 27 27	3 25	19	14 50 3	5 6

Messrs. Braae and Fischer Petersen announce that their supposition that comet 1919*b* (Brorsen-Metcalf) has made two revolutions since 1847 is not correct; its true period is 72·1 years.

FALL OF A METEORITE IN AMERICA.—The daily papers report that on the night of November 27 last a large meteorite descended into Lake Michigan, and that the object was seen before its fall by many persons over a wide extent of country. If this event is fully corroborated, it seems quite possible that the meteorite may have been a fragment of Biela's lost comet, like the Mazapil meteorite of November 27, 1885, on which date there occurred a great shower of ordinary meteors.

The earth passed through the orbit of Biela's comet on that occasion, and must have been very near, if not involved in, the denser portion of the material forming the remains of the comet. The latter had a periodic time of revolution amounting to about 6¾ years, and if we add five periods to the last return near the end of 1885 we arrive at the present time, so that a display of meteors was rendered quite probable. However, no very conspicuous shower occurred, though from reports sent in by various observers for the period November 19–25 a few meteors, including several of special brilliancy, were recorded from the right direction in Andromeda. In all, seventeen paths appear to be conformable to this shower, and the radiant is indicated at 29°+44° near the star γ Andromedæ.

On the same night, at 9h. 50m., that the meteorite is said to have fallen in America, a fireball was seen at Bristol descending slowly in the north-eastern sky, but the atmosphere was very hazy and few stars were visible. Observations of this object from other places would be valuable.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Monday, when the report of the council was presented and the president, Sir J. J. Thomson, delivered an address. In the evening fellows and their guests dined together at the Royal Palace Hotel, Kensington, this being the first anniversary dinner since 1913. The assembly received with much satisfaction the announcement of the president that the Prince of Wales is to be admitted a fellow of the society early next year.

The report of the council is largely occupied with an account of the origin and constitution of the International Research Council and the related National Research Council. It is hoped that the British Government will consent to make the annual contribution required from countries forming part of the international organisation, in order to place the Council on a sound financial basis. The report refers also to the increased need of financial assistance for the promotion of research in pure sciences and to developments of the National Physical Laboratory under Sir Richard Glazebrook's directorship. The names of the new officers and council were announced in NATURE of November 13 (p. 295)

In his presidential address Sir Joseph Thomson referred to the retirement of Sir Alfred Kempe (treasurer) and Dr. Schuster (secretary) and to the invaluable services which these officers have rendered to the society. He also announced with regret that the assistant secretary, Mr. R. Harrison, has been obliged to resign his office owing to ill-health. The subjoined extracts are from the president's address.

Einstein's Theory.

I cannot pass over without notice the remarkable result that was announced at our first meeting this session: that the observations made at the eclipse of May 29 showed that light was deflected, when passing close to the sun, by an amount which, within the somewhat wide limits of the experimental error, agreed with that predicted by Einstein.

The deflection of light by matter, suggested by Newton in the first of his Queries, would in itself be a result of first-rate scientific importance; it is of still greater importance when its magnitude supports the law of gravity put forward by Einstein, a law which has explained the long-standing difficulty of the motion of the perihelion of Mercury.

On Einstein's law the velocity of light passing

through a field of gravitational attraction depends upon the gravitational potential, and diminishes as the potential diminishes. Thus the gravitational field round the sun acts like a refracting atmosphere, the refraction diminishing as the distance from the sun increases.

Though there are some hundreds of theories of gravitation, Einstein's is the only one which has predicted a result which has been verified by experience. On Einstein's, as on several other theories, changes in gravitational attraction travel with the velocity of light, and also the mass of a body varies with the proximity of other bodies.

In view of the statements in the Press about the overthrow of the Newtonian law, it may be well to point out that it is only in most exceptional cases—cases which are very difficult to realise—that the difference between the effects of the two laws is appreciable.

The modified theory of relativity by which Einstein arrived at this result is of remarkable interest and subtlety. The space around matter is on this theory distorted by an amount which diminishes as the distance from the matter increases, so that an observer in an aeroplane, if he were provided with infinitely delicate instruments, would, as he rose in the air, find the shapes of objects on the ground continually changing; and again the ratio of the circumference to the diameter of a circle would be changed to a minute amount by placing a weight at the centre of the circle. The laws of morality have been said to be a question of latitude; on Einstein's view those of geometry are a question of altitude.

On Einstein's view, gravitation is due to a particle trying to find the easiest way through space distorted and disturbed in this way. We may put it as follows:—The dynamical principle of least action, when applied to a particle moving through a space of this kind, would lead to a different path from that which would be pursued if the space were Euclidean, and this difference in path is that which would be produced if we supposed the space to remain Euclidean and the particle to be acted upon by an appropriate force. This force is what we call gravitational attraction. Thus we can represent the effect of this distorted space by the effects of suitable forces, and I expect it will be found that even the most enthusiastic relativitists will be tempted to think in terms of forces rather than in those of the geometry of non-Euclidean space.

If the distortion of space were very great, the customary methods of dynamics might lose their significance; and the question arises: Will, on Einstein's theory, the space inside an atom be so far from Euclidean that ordinary dynamical methods are unjustifiable? The answer to this question is, "No." There are two lengths which have special significance in connection with the atom; one of these is what we call the radius of the atom, and is of the order 10^{-8} cm.; the other we call the radius of the electron, and is about 10^{-13} cm. Even at the smaller of these distances the gravitational potential due to the mass of the atom, and therefore the distortion from Euclidean space, would be exceedingly small compared with the corresponding quantities due to earth at its surface, so that there is no special distortion inside the atom, except at distances from the centre which are infinitesimal even when compared with the radius of an electron.

One point of interest in connection with any view we take about mass is that, on the electrical theory of matter, the massive part of the atom is invariably positively charged, so that any state of space which we associate with mass ought to involve something corresponding to a positive charge of electricity.

The determination of the consequences of Einstein's theory on the principles of relativity, where the ideas of space and time are so intimately correlated that time has to be treated as a fourth-space dimension, introduces us into a space of four dimensions which we cannot visualise, and the properties of which are very remote from our experience. It is this which makes any general explanation of Einstein methods so difficult. To the analyst the difficulties presented by space of four dimensions are mainly those of an increase in the number of his symbols and equations; his difficulties begin when he has to explain his results to someone who is not an analyst. It is a remarkable and most interesting fact, from the point of view of either physics or metaphysics, that from such transcendental considerations as those I have indicated should have emerged a result so closely connected with such a prosaic thing as that it is more tiring to go upstairs than down.

According to Einstein's theory, the Fraunhofer lines in the sun must be displaced towards the red. This effect, though looked for by several observers, has not been confirmed; but even should it turn out that the theory has greatly to be modified, or even abandoned, its conception and development will, I think, always be regarded as one of the great triumphs of human thought.

Another interesting consequence of Einstein's theory is the exceeding minuteness of structure which it demands from matter. The electron, with a radius of 10^{-13} cm., carried our notions of the minuteness of some constituents of the universe far beyond those associated with the older atomic theory, but the size of the centres of disturbance, which in Einstein's theory are associated with matter, bears to the size of the electrons about the same proportion as the size of the smallest particle visible under the most powerful microscope to that of the earth itself.

I am afraid that the termination of the war has not brought to an end the difficulties in the way of scientific research in this country. Not the least of these is the difficulty and expense of procuring apparatus; it is perhaps surprising that in these circumstances the Government should have put obstacles in the way of the importation of philosophical instruments. Another very real difficulty is that the large increase in the number of students in our universities has greatly increased the educational duties of many of our most active workers, and so diminished the time they can devote to research.

The demands of war required large quantities of substances which previously were obtainable only in small quantities and at great expense. Prominent among these is helium, which can now be procured on a scale which, measured by laboratory standards, is unlimited. Such supplies of helium put cryogenic research on a new footing, and render possible investigations which promise to be of the greatest importance to many different branches of science. It is greatly to be regretted that in this country, the birthplace of cryogenic research, we have no adequately equipped cryogenic laboratory.

The Medallists.

The COPLEY MEDAL is awarded to WILLIAM MADDOCK BAYLISS.

Prof. W. M. Bayliss has been engaged in the investigation of physiological problems for the last thirty-five years. His work has ranged over a wide field. His paper with Starling on the electrical phenomena of the mammalian heart was the first to give the correct form of the normal variation, as confirmed by later investigations with the spring galvanometer. Again, he and Starling showed that the pancreatic secretion was effected by the production of a

specific chemical messenger, which travelled by the blood, and not by the stimulation of nerve-endings and the passage of impulses through nerves and the central nervous system. They showed that this secretin was but a type of a whole group of substances which they designated hormones. The discovery of these hormones, and the precise definition of their nature and of the conditions of their activity, mark an important epoch in the development of our knowledge of the organs of the animal body. Prof. Bayliss's researches on the mode of action of enzymes and on the closely related questions with regard to the nature of colloidal solutions have obtained universal recognition. The war led to Prof. Bayliss making a great advance in practical medicine. He studied the condition known as shock, which follows great loss of blood. The condition had previously been treated by the injection of saline solution, but the effect produced was characteristically transitory, and sometimes no benefit accrued at all. Prof. Bayliss, amongst other things, proved that perfused fluid to be effective must contain colloidal matter sufficient to give the osmotic pressure of the normal colloidals of the blood.

A ROYAL MEDAL is awarded to PROF. JOHN BRETLAND FARMER for his researches in botany, especially in the cytology and anatomy of plants.

Prof. Farmer's work is characterised by the fundamental importance of the problems worked upon; thus his memoirs on the meiotic phase (reduction division) in animals and plants are of as great value to zoologists as to botanists, and his conclusions and interpretations of the complex nuclear changes which precede the differentiation of the sexual cells have stood the test of criticism, and remain the clearest and most logical account of these very important phenomena. His papers, in collaboration with his pupil, Miss Digby, on the cytology of those ferns in which the normal alternation of generations is departed from has thrown new light on problems of the greatest biological interest, and especially on the nature of sexuality. In his cytological work on cancerous growths Prof. Farmer has established the close similarity between the cells of malignant growths and those of normal reproductive tissue.

A ROYAL MEDAL is awarded to MR. JAMES HAYWOOD JEANS.

Mr. Jeans has successfully attacked some of the most difficult problems in mathematical physics and astronomy. In the kinetic theory of gases he has improved the theory of viscosity, and, using generalised co-ordinates, has given the best proof yet devised of the equipartition of energy and of Maxwell's law of the distribution of molecular velocities, assuming the validity of the laws of Newtonian dynamics. In dynamical astronomy he took up the difficult problem of the stability of the pear-shaped form of rotating, incompressible, gravitating fluid at a point where Darwin, Poincaré, and Liapounoff had left it, and obtained discordant results. By proceeding to a third order of approximation, for which very great mathematical skill was required, he showed that this form was unstable. He followed this up by the discussion of the similar problem when the fluid is compressible, and concluded that for a density greater than a critical value of about one-quarter that of water the behaviour is generally similar to that of an incompressible fluid. For lower densities the behaviour resembles that of a perfectly compressible fluid, and with increasing rotation matter will take a lenticular shape and later be ejected from the edge.

The DAVY MEDAL is awarded to PROF. PERCY FARADAY FRANKLAND for his investigations in three sections of chemical science.

Prof. Frankland's early work on the illuminating power of burning hydrocarbons was considerable in amount, and had the further merit of inspiring others in the study of combustion. He was one of the first after Pasteur to study seriously the chemical reactions which occur during the vital processes of numerous lower organisms, and to apply such reactions to the preparation of pure products. During the last twenty years he has devoted himself to the elucidation of the relationship existing between the chemical constitution and the rotatory power of optically active substances.

The SYLVESTER MEDAL is awarded to MAJOR PERCY ALEXANDER MACMAHON.

Major MacMahon's researches on the combinatory analysis and on subjects allied to the partition of numbers are of the highest value, and display great originality and invention. He has shown equal power in the discovery and treatment of the wonderful ranges of partition theorems which are derivable from the theory of elliptic functions, and of the similar theorems to be obtained by the application of analysis to purely arithmetical principles.

The HUGHES MEDAL is awarded to DR. CHARLES CHREE.

Dr. Chree has for many years devoted himself to the intimate study of the phenomena of terrestrial magnetism, notably those which are recorded by self-registering instruments. He has investigated the differences which occur in the diurnal variation on quiet or moderately disturbed days, studied the initial stages of magnetic storms, and investigated various problems connected with the relation of solar phenomena and manifestations of terrestrial magnetism. Perhaps the most notable result obtained is that called by Dr. Chree the "acyclic change." This manifests itself on taking the averages of quiet days, when it appears that the mean value of the magnetic force is not the same at the end as it was at the beginning of the 24-hourly period, but shows a difference which is always in the same direction.

THE HYDRO-ELECTRIC SURVEY OF INDIA.[1]

AT a time when so much enterprise and energy are being displayed in collecting facts and data concerning the world's water-power resources, the issue of a preliminary report on the water-power resources of India is an incident of considerable interest and importance. The investigation was commenced in 1918 under instructions from the Indian Government by the late Mr. G. T. Barlow, C.I.E., who was placed in charge of the survey, with Mr. J. W. Meares as his assistant. The untimely and deplorably sudden death of Mr. Barlow in April, 1919, towards the close of the tour of inspection, left the compilation of the report in the hands of Mr. Meares, who was appointed as his successor in the post of Chief Engineer. Mr. Meares has discharged his exacting task in a very able manner. The removal of Mr. Barlow's collaboration was, of course, a serious deprivation, as a number of places were visited by him unaccompanied; and, although he compiled his notes with every care, his unrecorded impressions would have been of great value. Notwithstanding this the report is excellently put together, and full of useful information.

The earliest water-power installation in India was the electric lighting plant of the town of Darjeeling, carried out by Mr. Meares himself in 1897. Five years later considerable power for industrial purposes was developed in Mysore from the River Cauvery. Then nothing of importance happened until the initia-

1 "Hydro-electric Survey of India." Preliminary Report on the Water-power Resources of India. Ascertained during the Season 1918–19 by the late G. T. Barlow, assisted by J. W. Meares. Compiled by J. W. Meares. Pp. vii+108+iii plates. (Calcutta: Superintendent Government Printing, India.) Price Rs. 3.2 or 4s. 9d.

tion of the great Tata hydro-electric power project at Bombay, which has recently been completed. The country is known to abound in hydraulic possibilities, but, owing to the paucity of important manufacturing industries, no serious attempt has been made to exploit these possibilities, except in a few rare instances.

The difficulty in regard to the promotion of power-development schemes is the erratic incidence of the rainfall. India differs very greatly in this respect from other countries. The rainfall is seasonal, often tremendously heavy, followed by protracted spells of drought. In amount it ranges from 500 to a few inches.

Apart from canals, the mountainous regions, where the rainfall is a maximum, are the natural sources of water-power, but here there is a certain disability in that they lie largely in unsettled districts in the north inhabited by uncivilised tribes. "Except in localities where storage on a large scale is possible, such as the Western Ghats and possibly the uplands of the Central Provinces, the greater part of the monsoon rainfall of India must necessarily pass to the great rivers and canals undeveloped for power purposes." The Jaldaka River in the Bengal Duars is instanced as a case in point. The catchment area is 250 square miles, and the annual rainfall not less than 150 in.—probably 200 in. as an average. In the seven months from April to October the total fall amounts to some 75,000,000,000 cubic ft., giving an average flow of nearly 4000 cubic ft. per second, yet the flow gauged in April this year was only 170 cubic ft. per second. Add to this that a single day's rainfall may reach, and even exceed, 10 in., and the difficulty of controlling such extremes becomes at once apparent.

In consequence of the prevalence of conditions such as these, many Indian rivers during the dry season sink to insignificant streamlets. Storage, therefore, during the monsoon period is the only possible means of obtaining continuous supplies of water. But in most localities this is not economically possible. Certain seasonal industries, such as tea-drying and kindred processes, might be served by intermittent supplies, but the cost would be relatively higher than by a continuous supply.

As indicating the backward state of electrical development in India, the following figures are interesting. The number of watts installed per head of population in Canada is 148, in Australasia 62, in South Africa 57, in the British Isles 33, and in India less than 1.

The total brake-horse-power of all kinds is set down approximately as follows:—

Assam	22,550	
Bengal	201,518	
Bihar	2,325	(apart from collieries)
Bombay	782,872	
Burma	17,750	(exclusive of rice mills, etc.)
Central Provinces	32,773	
Madras	39,568	
Punjab	15,734	(steam only)
United Provinces	38,548	
Grand Total ...	1,153,638	

No estimate of the total water-power available for development is given or attempted. Mr. Meares states that it would take several years to ascertain it, even approximately. A statement is set out of existing hydro-electric plants and a number of possible sites for developing water-power are discussed. The report concludes with a series of practical notes and suggestions on methods of collecting and tabulating the necessary data, with a view to the future work of the survey. BRYSSON CUNNINGHAM.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A further benefaction of 1000*l.* has been received by Prof. Nuttall on behalf of the institute for parasitology from the executors of the late Lord Strathcona and Mount Royal, in fulfilment of a promise made in 1910 to contribute that sum when the sum of 6000*l.* had been collected from other sources.

Dr. F. H. A. Marshall, fellow of Christ's College, has been appointed reader in agricultural physiology.

Mr. P. Lake, of St. John's College, has been appointed reader in geography.

Mr. W. B. R. King, of Jesus College, has been appointed assistant to the professor of geology, and Mr. T. C. Nicholas, fellow of Trinity College, to be demonstrator in geology.

OXFORD.—On November 2 an amendment to the Responsions statute was moved in Congregation by Prof. Gilbert Murray. This, if carried, would have had the effect of restricting the exemption from compulsory Greek to candidates in the pass schools and in the honour schools of natural science and mathematics. The amendment was lost on a division by 104 votes to 123. This decision will, no doubt, lead to a reopening of the question of exemption before Congregation, with a possible appeal to Convocation before a final settlement can be reached.

ON Friday, December 5, the Marquess of Northampton will distribute prizes and certificates at the Northampton Polytechnic Institute, Clerkenwell, E.C.1.

OWING to the lack of fuel for heating purposes, the University of Budapest has been unable to resume its activities this session. It is not anticipated that the resumption of work will be possible until next spring.

THE RIGHT HON. VISCOUNT HALDANE OF CLOAN, president of Birkbeck College, will receive the college graduates and deliver an address on "What is Truth?" at the celebration of the ninety-sixth anniversary of founder's day of the college on Friday, December 12. The chair will be taken at 8 p.m.

THE Dean of the faculty of medicine of the University of Paris has directed our attention to the reorganisation of the courses of instruction and the reopening of the laboratories and clinics in this faculty. A booklet has been published by Messrs. Masson (price 1 franc) giving a valuable and interesting historical account of the school, together with complete information with respect to the various courses. The booklet is admirably produced, and illustrated with twenty-one well-executed photographic plates. It should be in the hands of all those who wish to make use of the great resources now open to them. There should be many of these. Some of the clinical courses are given in vacation time—a fact which makes them available to those who might otherwise find it impossible to make a visit to Paris.

THE Prime Minister has appointed a Committee "to inquire into the position to be assigned to the classics (*i.e.* to the language, literature, and history of ancient Greece and Rome) in the educational system of the United Kingdom, and to advise as to the means by which the proper study of these subjects may be maintained and improved." The constitution of the Committee is as follows:—The Marquess of Crewe (chairman), Sir George Adam Smith, the Rev. C. A. Alington, Mr. S. O. Andrew, Miss M. D. Brock, Prof. H. J. Browne, Prof. J. Burnet, Mr. T. R. Glover, Sir Henry Hadow, Miss K. Jex-Blake, Prof. W. P. Ker,

Mr. J. G. Legge, Mr. R. W. Livingstone, Mr. G. A. Macmillan, Prof. Gilbert Murray, Mr. Cyril Norwood, Prof. W. Rhys Roberts, Mr. C. E. Robinson, Prof. A. N. Whitehead, and Mr. C. Cookson (secretary). Communications intended for the Committee should be addressed to Mr. C. Cookson at the offices of the Board of Education, Victoria and Albert Museum, Exhibition Road, South Kensington, S.W.7.

THE eighth annual Conference of Educational Associations will be held in University College, Gower Street, London, W.C.1, from Wednesday, December 31, 1919, to Saturday, January 10, 1920. Mr. H. A. L. Fisher, President of the Board of Education, will give an address at the inaugural meeting, and the following are among the subjects to be discussed at meetings of some of the associations:—National Association of Manual Training Teachers and Educational Handwork Association: (*a*) The Measurement of Practical Ability and (*b*) Handwork and Science. British Psychological Society—Education Section: The Development of Mental Tests. Association of Science Teachers: Anti-gas Fans—with Experiments. Geographical Association: The Present Position of Geography in the Upper Forms—Some Causes and Possible Remedies; Spitsbergen; Islands, Peninsulas, and Empires; and Rainfall Considered as a Geographical Function. The Association of Science Teachers has arranged for a demonstration of Dr. Wilson's astronomical model at intervals throughout Monday, January 5.

THE inauguration of the University of Strasbourg under the new *régime*, which took place on November 22, was naturally an event of importance. The position of Strasbourg as the eastern outpost of French culture gives to its University a position of outstanding prestige. The authorities responsible for its "reconstruction" under the tricolour intend to maintain a very high standard of studies, and are especially anxious to attract students from this country. There are six faculties (law, sciences, letters, medicine, and Protestant and Catholic theology) and a *personnel enseignant* of 170 professors and *maîtres de conférence*. A well-endowed Société des Amis de l'Université (2 rue Geiler, Strasbourg) has just been founded, and one of its chief objects will be that of welcoming students (of either sex) from abroad and of making life attractive to them. Inquiries should be addressed to the society. The cost of living is much to the advantage of British residents on account of the very favourable rate of exchange. The imposing university buildings (opened in 1884 at a cost of 2,000,000*l.*) stand in the centre of the city, and close at hand is the magnificent library of 1,200,000 volumes, so rich in German literature. Strasbourg itself is, without doubt, one of the most attractive and well-governed cities in Western Europe, and its close proximity to the beautiful forests of the Vosges gives it a further advantage as a place of residence for British students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 20.—Sir J. J. Thomson, president, in the chair.—W. J. **Johnston**: A linear associative algebra suitable for electro-magnetic relations and the theory of relativity. The algebra is based on four fundamental units i, j, k, o. The square of each unit is -1, while the other binary products are polar ($ij=-ji$, $io=-oi$, etc.). This algebra is associative. i, j, k are interpreted as mutually rectangular unit vectors in Euclidean space, while o is a unit vector in the fourth dimension perpendicular to the other three. Let ω be the pure imaginary scalar $ct\sqrt{-1}$ and $W=c^{-1}\phi\sqrt{-1}$, where ϕ is the scalar potential, then if (F, G, H) is the ordinary vector potential the vector

$$U=iF+jG+kH+oW$$

is the fourfold vector potential. If ∇_1 is the operator

$$i\frac{\partial}{\partial x}+j\frac{\partial}{\partial y}+k\frac{\partial}{\partial z}+o\frac{\partial}{\partial \omega},$$

then the electric and magnetic forces are the six components of $c\nabla_1 U$, the scalar part of which vanishes; and the eight scalar equations of the electrodynamic field which connect these forces are expressed by the single equation $\nabla_1(\nabla_1 U)=0$. This equation in the equivalent form $\nabla_1^2 U=0$, when interpreted in terms of ordinary space, expresses that all the disturbances are propagated from their point-sources with uniform velocity c.—Sir Joseph **Larmor**: Generalised relativity, in connection with Mr. W. J. Johnston's symbolic calculus. If ijk are polar units, so that $i^2=-1$, $ij=-ji$, then $ik+jy+kz$ is a binary form involving the position of a point xyz and that of a trihedron ijk. So far as regards relative position, a displacement of the one is the same thing as a displacement of the other. A vector $iF+jG+kH$ represents an entity independent of the trihedron of reference, so is invariant for changes of the latter. Operations of addition and multiplication of vectors give results which are also invariant. Similar statements apply in geometric algebras of higher dimensions, and the scalars involved may be ordinary imaginaries. With the four dimensions x, y, z, $ct\sqrt{-1}$ of Minkowski, Mr. Johnston has shown that the vector forces of the electro-dynamic field are specified by $\nabla_1 U$, where U is the fourfold vector potential, and the eight equations of the field are summed up in $\nabla_1^2 U=0$. But a source, naturally conceived as a singular point in ordinary space, complicates now into a Minkowski line. Again, all the geometric quantities natural to any Euclidean hyperspace are those which are evolved immediately from the addition and multiplication of vectors in it. It is proved that the possible types of disturbance propagated through an æther, which conform to the principle of relativity, are restricted to the single one specified by Maxwell's electro-dynamic scheme. In an appendix the Einstein idea of gravitation is developed as a theory of correspondence of modes of action of a physical system; it appears, at any rate on this view, that it does not involve displacement of the solar spectral lines.—G. E. **Bairsto**: The variation with frequency of the conductivity and dielectric constant of dielectrics for high-frequency oscillations.—F. J. W. **Whipple**: Equal parallel cylindrical conductors in electrical problems. Dr. Alexander Russell has recently directed attention to the practical importance of determining the mutual induction between currents of high frequency carried by parallel cylindrical conductors, and pointed out that the problem is mathematically equivalent to that of finding the distribution of static charge on two electrified conductors. The first part of the present paper is devoted to the solution of this problem. The coefficients of mutual and self-induction and the force between the cylinders, regarded as carriers of high-frequency currents, concentrated on the surfaces, are also investigated.—G. A. **Schott**: The scattering of X- and γ-rays by rings of electrons. A crucial test of the electron-ring theory of atoms. This paper investigates the effect of the regular spacing of the electrons of a ring on the scattering of X- and γ-rays, treated as undamped simple harmonic wave-trains of high frequency. The ring, whether at rest or revolving uniformly about its axis, diffracts the waves incident on it in all directions, but not equally. For a single electron the law of distribution is that of Sir J. J. Thomson's simple-pulse theory, but it deviates

from it as the number of electrons increases, more energy going forward in the direction of the incident rays than backward. This asymmetry is retained, though to a less extent, by an irregular assemblage of similar electron rings with their axes distributed uniformly in space. An expression is obtained for the scattering coefficient, or mean total energy scattered per ring per unit intensity of the incident radiation, in a finite form, depending upon the number of electrons in the ring and on the ratio which its radius bears to the wave-length of the incident radiation.

Physical Society, November 14.—Prof. C. H. Lees, president, in the chair.—S. **Butterworth**: The self-inductance of single-layer flat coils. Two formulæ are established for the computation of the self-inductance of single-layer flat coils, one for the case when the inner and outer radii are not very different, and the other for the case of small inner radius. The two formulæ are shown to be consistent and capable of including all possible cases.—Dr. N. W. **McLachlan**: An experimental method of determining the primary current at break in a magneto. A method of obtaining experimentally the current at break in a magneto is described. A condenser is connected across the secondary winding to reduce the voltage below that required to cause sparking at the safety gap. The peak voltage due solely to interruption of the current at any speed is found. The interrupted direct current necessary to give the same peak voltage is also found by using a calibrating circuit. The magnitude of this current is equal to that broken in the magneto. The influence of the secondary condenser on the primary current at high speeds is discussed.—F. W. **Newman**: A new form of Wehnelt interrupter.

Royal Meteorological Society, November 19.—Sir Napier Shaw, president, in the chair.—Lieut. C. W. B. **Normand**: Effect of high temperature, humidity, and wind on the human body. The climatic conditions under which a wet bulb, restricted to a certain maximum rate of evaporation and having an initial temperature of 36·5° C., will neither gain nor lose heat are derived from kata-thermometer and wet-bulb formulæ. The application of these results to the human body is then considered, and, on the assumption that conditions resulting in a rise of body temperature above 36·5° C. must be fatal, the upper limits to liveable climatic conditions are deduced. The scorching, and sometimes deadly, simoom of tropical deserts is considered to be a case of the onset of a high wind without necessarily a change of temperature or humidity, converting liveable into unliveable conditions. The suggestion is also made that an essential feature of heat-strokes may be that a portion of the body has been exposed for a time to air conditions which are above the limit for existence. The wet kata-thermometer and wet-bulb formulæ were found to furnish quite discordant results regarding the behaviour of a wet surface under varying wind velocities, and it is suggested that this discrepancy is due to a less efficient wetting of the kata-thermometer bulb and to a consequently restricted rate of evaporation from it.—Capt. A. J. **Bamford**: Some observations of the upper air over Palestine. This paper gives a brief summary of some upper-air observations made in Palestine during the last two years. Tables and graphs are given showing the monthly averages of the horizontal movements at different altitudes over three stations, at one of which (near Ramleh) observations were kept up continuously for a year. The second part of the paper deals with vertical velocities, and includes frequency curves, showing for each of the layers 0–2000 ft., 2000–4000 ft., and 4000–6000 ft. the number of times in each month that the observed velocities differed from the theoretical ones by not more than 10, 20, 30, or 40 per cent., etc. The lowest layer is appreciably the most varied, and in it differences of 50 per cent. are not unusual, although the average velocity differs very slightly from theory. In the other layers there is a distinct increase in the compactness of the frequency curves, while the average velocity changes from slightly above to slightly below the theoretical value.—E. G. **Bilham**: Barometric pressure and underground water-level. The results recently obtained from a study of an experimental well with autographic registration at Kew Observatory, Richmond, Surrey, are compared with some earlier records obtained by Dr. Isaac Roberts at Maghull, near Liverpool, and by Prof. K. Honda in the neighbourhood of Tokyo, in Japan. As at Kew, the sensitiveness of the water surface at Maghull to pressure changes varies considerably, high sensitiveness being associated with saturation of the soil by previous heavy rainfall. In Japan it was found that in surface wells the water-level was not affected by pressure changes, sensitiveness being exhibited by deep artesian wells only. Prof. Honda has pointed out that by determining the sensitiveness of a well to barometric pressure the extent to which pressure changes affect strata at a given depth below the surface can be deduced. Data for Japan and the British Isles obtained in this way show marked points of difference.

CAMBRIDGE.

Philosophical Society, November 10.—Mr. C. T. R. Wilson, president, in the chair.—Dr. **Hartridge**: Colorimeter design.—J. T. **Saunders**: A note on hydrogen-ion concentration and photosynthesis. Spirogyra and elodea during photosynthesis cause the surrounding water to become markedly alkaline. Acids are very rapidly absorbed.—J. **Gray**: (1) The effects of some ions on spermatozoa. A suspension of Echinus spermatozoa in sea-water behaves in an electric field or in the presence of hydrogen ions or trivalent ions in the same way as an emulsion of albumen in alkaline solution. (2) The effects of ions on ciliary movement (gills of *Mytilus edulis*). By far the most potent ions in sea-water which affect ciliary movement are hydrogen ions and hydroxyl ions.—C. **Warburton**: Note on the solitary wasp, *Crabro cephalotes*. A small colony of *C. cephalotes* took possession in August, 1919, of a log in the author's garden, and afforded an opportunity of studying their habits with some accuracy. Observations were made on the time occupied in capturing and bringing home their prey and in packing them in the burrows.—Miss M. D. **Haviland**: Preliminary note on the life-history of a Proctotrypid (Lygocerus sp.) hyperparasite of Aphidius. *Lygocerus Cameroni*, Kieff (Proctotrypidæ), is a hyperparasite of certain Braconid parasites of plant-lice, and not a parasite of the aphides themselves, as has hitherto been assumed.—H. J. **Snell** and W. H. **Tams**: The natural history of Rodrigues, with exhibits. The paper gives a brief account of the island of Rodrigues as it at present exists. Since it was first discovered it appears to have been completely swept by fire, save only for peculiar deep pits in the elevated coral rock which in places overlies the volcanic. Here a certain number of the indigenous plants still survive, but probably the species in the flora are only half as numerous as when the island was first discovered; great damage has also been done by pigs and goats. The fauna previously described was almost in its size that of a coral island, but the present collections reveal much larger numbers of species and more variety, indicating probably a greater age for the island; the fauna also shows a close parallel to that of Mauritius and other volcanic islands in its adaptability to island conditions.

MANCHESTER.

Literary and Philosophical Society, November 4.—Prof. F. E. Weiss in the chair.—Prof. W. H. **Lang**: One of the simplest land-plants, *Hornea Lignieri*. The further results obtained by Dr. R. Kidston and Prof. W. H. Lang in the study of the silicified Old Red Sandstone plants at Rhynie were described. Two species of Rhynia are now distinguished, *R. Gwynne-Vaughani* and *R. major*. The latter is the larger in all its parts, and differs in some details of anatomy. These plants are rootless and leafless, and consist of a subterranean rhizome with rhizoids, dichotomously branched cylindrical aerial stems, and large terminal sporangia. Another equally simple plant, associated with these in the family Rhyniaceæ, has been discovered and investigated. This, *Hornea Lignieri*, consisted of rhizomes, branched stems, and terminal sporangia, without roots or leaves. The rhizomes were lobed parenchymatous structures, suggesting comparison with the protocorm of certain species of Lycopodium. The stems branched dichotomously, and had a simple central cylinder, cortex, and epidermis. No stomata have yet been discovered in this plant, as they have in Rhynia, but its organisation suggests a similar land-habit. The sporangia are remarkable in the presence of a columella-like central region, making the spore cavity dome-shaped. These simple vascular Cryptogams suggest comparisons with Bryophyta and Algæ.

PARIS.

Academy of Sciences, November 10.—M. Léon Guignard in the chair.—M. **Hamy**: A case of diffraction of images of circular stars.—H. **Douvillé**: The geology of Mont Blanc.—A. **Blondel**: A solution of heterochromatic photometry permitting of a physical measurement of the luminous intensity. The instrument proposed is based on the inversion of a spectrograph, the slit being replaced by a thermocouple.—L. **Cuénot**: The coaptation of the anterior femurs and of the head in the Phasmidæ.—E. **Bompiani**: Surfaces of translation and minimum surfaces in curved space.—B. **Baillaud**: Return of the Finlay comet; re-found by M. Schaumasse; compared by M. Fayet with the recent Sasaki comet. The comet discovered on October 25 by Sasaki is considered by M. Fayet, director of the Nice Observatory, as identical with the periodic Finlay comet recently found by Schaumasse.—A. **Véronnet**: Time and temperature of formation of a star. The author concludes that the sun originally could not have had a temperature more than three times its present temperature, or a radius more than double the present one. Even in this case the time of formation would have to be less than a million years. The physical conditions have never been greatly different from the existing ones.—M. **Girousse**: The calculation of the current thrown into the ground by the rails of electric tramways.—H. **Colin** and Mlle. A. **Chaudin**: The diastatic inversion of saccharose: influence of the products of the reaction on the velocity of hydrolysis. In all the cases studied the velocity of hydrolysis is a linear function of the fluidity of the solutions. The reduced velocity of hydrolysis of sugar by sucrase caused by the presence of lævulose or glucose must be attributed to the purely physical effect of increased viscosity.—L. **Chelle**: The detection of hydrocyanic acid in a case of poisoning. Its *post-mortem* transformation into thiocyanic acid. It is well recognised that hydrocyanic acid apparently disappears from the body at a certain period after death. It is now shown that this acid is not destroyed or transformed in an irreversible manner, but takes up sulphur and is converted into thiocyanic acid. The latter resists the action of putrefaction, and can be extracted from the tissues and reconverted by oxidation into hydrocyanic acid.—R. **Levaillant** and L. J. **Simon**: The action of methyl alcohol on sulphuryl chloride and on methyl chlorosulphonate.—J. **Barthoux**: Relation of volcanic eruptions and marine transgressions in Egypt.—A. **Briquet**: The age of the old littoral lines of the Bas-Champs of Picardy.—G. **Mouret**: The prolongation to the north-west of the zone of crushed rocks recognised between Asprières (Aveyron) and Fromental (Haute-Vienne).—Ph. **Glangeaud**: The plateau of Millevaches, its cycles of erosion, its ancient glaciers and peat-bogs.—J. **de Lapparent**: The conglomerates of the valley of la Bruche and the character of the breccias of sedimentary origin.—P. **Garrigou-Lagrange**: The kinematography of atmospheric movements and weather prediction.—C. E. **Brazier**: Relations of wind with gradient in the lower layers of the atmosphere.—A. **Goris** and Ch. **Vischniac**: Characters and composition of primeverose. The new sugar was isolated from two glucosides extracted from *Primula officinalis*. Its physical and chemical properties are given. Glucose and xylose are the products of hydrolysis, and primeverose is the first known biose of this composition.—G. **Tanret**: The *miellée* of the poplar. Melezitose has been isolated from the sugary deposit (*miellée*) found in warm seasons on the upper faces of the leaves of certain species.—J. **Amar**: Mechanism of the cough in respiratory diseases.—J. **Nageotte**: The formation of conjunctive fibres in a non-living medium at the expense of dead protoplasm.—MM. G. **Bertrand**, **Brocq-Rousseu**, and **Dassonville**: Destruction of *Sitotroga ceralella* by chloropicrin.

BOOKS RECEIVED.

Human Personality and its Survival of Bodily Death. By Frederic W. H. Myers. Edited and abridged by S. B. and L. H. M. Pp. xiii+307. (London: Longmans, Green, and Co.) 6*s*. 6*d*. net.

South: The Story of Shackleton's Last Expedition, 1914–17. By Sir Ernest Shackleton. Pp. xxi+376. (London: William Heinemann.) 25*s*. net.

Identification of the Economic Woods of the United States: Including a Discussion of the Structural and Physical Properties of Wood. By Prof. Samuel J. Record. Second edition, revised and enlarged. Pp. ix+157+vi plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

The Theory and Practice of Working Plans (Forest Organization). By Prof. A. B. Recknagel. Second edition, thoroughly revised. Pp. xiv+265+vi plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 9*s*. net.

Spiritual Pluralism and Recent Philosophy. By C. A. Richardson. Pp. xxi+335. (Cambridge: At the University Press.) 14*s*. net.

The Principles of Electrical Engineering and their Application. By Prof. Gisbert Kapp. Vol. ii.: Application. Pp. viii+388. (London: Edward Arnold.) 18*s*. net.

Asbestos and the Asbestos Industry: The World's Most Wonderful Mineral and Other Fireproof Materials. By A. Leonard Summers. (Pitman's Common Commodities and Industries.) Pp. ix+107. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Meteorology for All: Being Some Weather Problems Explained. By Donald W. Horner. With an introduction by C. S. Salter. Pp. xvi+184+vii plates. (London: Witherby and Co.) 6*s*. net.

Ions, Electrons, and Ionizing Radiations. By Dr. James Arnold Crowther. Pp. xii+276. (London: Edward Arnold.) 12*s*. 6*d*. net.

Psychology and the Day's Work: A Study in the

Application of Psychology to Daily Life. By Prof. Edgar James Swift. Pp. ix+388. (London: George Allen and Unwin, Ltd.) 10s. 6d. net.

Notions Fondamentales de Chimie Organique. By Prof. Charles Moureu. Sixième édition. Pp. vii+552. (Paris: Gauthier-Villars et Cie.) 16 francs.

Agriculture and the Farming Business. By O. H. Benson and George Herbert Betts. Pp. xvii+778. (London: Kegan Paul, Trench, Trübner, and Co., Ltd.) 10s. 6d. net.

Introduction to Physical Chemistry. By Prof. James Walker. Eighth edition. Pp. xiii+433. (London: Macmillan and Co., Ltd.) 16s. net.

The Outline of History. By H. G. Wells. Part i. Pp. 32+plates. (London: George Newnes, Ltd.) 1s. 2d. net

Examples in Electrical Engineering. By J. F. Gill and F. J. Teago. Pp. 173. (London: Edward Arnold.) 7s. 6d. net.

Memoirs of the Geological Survey: England and Wales. Explanation of Sheet 154. The Geology of the Country around Lichfield, including the Northern Parts of the South Staffordshire and Warwickshire Coalfields. By G. Barrow and others. With contributions by J. B. Hill and others. Pp. viii+302. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 9s. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 4.

ROYAL SOCIETY, at 4.30.—A. M. Williams: (1) The Adsorption of Gases at Low and Moderate Concentrations. Part I: Deduction of the Theoretical Adsorption Isotere and Isotherm. Part II: Experimental Verification of the Form of the Theoretical Isoteres and Isotherms. (2) The Adsorption of Gases at Low and Moderate Concentrations. Part III: Experimental Verification of the Constant in the Theoretical Adsorption Isotere.—T. R. Merton: (1) The Secondary Spectrum of Hydrogen. (2) The Spectra of Isotopes.—E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces, Part II.—F. Horton and Ann C. Davies: An Experimental Determination of the Critical Electron Velocities for the Production of Radiation and Ionisation on Collision with Argon Atoms.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. C. F. Sonntag: The History of Baths and Bathing in Britain before the Norman Conquest.

CHEMICAL SOCIETY, at 8.—H. Henstock: Di-phenanthryl.—B. D. Steele and H. G. Denham: A New Sulphuretted Hydrogen Generator.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—*Discussion*: On the Recently Published Report on the Teaching of Obstetrics and Gynæcology to Medical Students and Graduates in London. Dr. T. W. Eden will introduce the discussion, and a Criticism of the Report will be read by Dr. H. Spencer.

FRIDAY, DECEMBER 5.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds Technical College, Leonard Street, E.C. 2), at 7.—H. M. Barlow: Thermionic Magnifiers.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—W. B. R. King: Geological Work on the Western Front.

TECHNICAL INSPECTION ASSOCIATION (at the Royal Society of Arts), at 7.30.—R. D. Summerfield and H. J. Davey: Inspection and Testing of Materials.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. C. H. Mott: Intratracheal Insufflation of Chloroform; a Report on 357 Cases.

MONDAY, DECEMBER 8.

VICTORIA INSTITUTE (at the Central Hall, Westminster), at 4.30.—A. W. Sutton: The Ruined Cities of Palestine, East and West of the Jordan.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore, S.W. 7), at 5.—Lt.-Col. W. J. Johnston: The New Inch and Quarter-inch Maps of the Ordnance Survey.

BIOCHEMICAL SOCIETY (at the Lister Institute), at 5.30.—B. Moore, E. B. R. Prideaux, E. Whitley, and A. Webster: (1) Season Variations in Reaction of Sea Water Due to Photosynthesis; (2) Fixation of Atmospheric Nitrogen by Marine Algæ.—B. Moore and E. Whitley: Velocity of Photo-synthesis by Green, Brown, and Red Seaweeds Respectively in Light of Varying Intensity.—A. Slator: The Rate of Inactivation of Yeast-cells.—I. S. MacLean: Composition of Yeast Fat.—C. J. Martin: (1) Method of Preparation of Sörensen's Phosphate Solutions in Absence of Pure Salts. (2) Adjustment of Reaction of Media by the Use of α-Naphtholphthalein.—A. Harden and S. S. Zilva: Production of Water-soluble B by *S. ellipsoideus*.

SURVEYORS' INSTITUTION (Junior Meeting), at 7.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. T. Hewitt: Synthetic Drugs (Cantor Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association), at 8.—R. J. Glinn: Large Boiler Units.

TUESDAY, DECEMBER 9.

ROYAL SOCIETY OF ARTS (Colonial Section), at 4.30.—Sir Edward Davson: Problems of the West Indies.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. F. Farmer: Demonstration of the "Carbro" Process.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. H. Hutton: The Leopard Men of the Naga Hills.

WEDNESDAY, DECEMBER 10.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at the College of Preceptors).

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Botanical Department, Imperial College of Science and Technology), at 11.30.—Annual General Meeting. Exhibitions and Communications.

CONJOINT BOARD OF SCIENTIFIC SOCIETIES (at the Royal Society), at 3.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Rear-Admiral Sir W. E. Goodenough: Light Cruisers.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Oliver Lodge: Some Possible Sources of Energy (Trueman Wood Lecture).

ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts), at 8.—J. D. North: Aircraft Undercarriages.

THURSDAY, DECEMBER 11.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Botanical Department, Imperial College of Science and Technology), at 10.30.—Discussion on the Integration of Mycological Research with Practice in Agriculture, Horticulture, and Forestry.—Sir A. D. Hall: The Administrative Problem.—Prof. V. H. Blackman: The Teaching Problem.—Dr. E. J. Russell: The Agricultural Problem.—F. J. Chittenden: The Horticultural Problem.—Prof. W. Somerville: The Forestry Problem.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Col. C. F. U. Meek: A Further Study of Chromosome Dimensions.—J. M. H. Campbell, C. G. Douglas, and F. G. Hobson: The Respiratory Exchange of Man During and After Muscular Exercise.—Dr. A. D. Waller: The Energy Output of Dock Labourers during Heavy Work.—C. H. Usher: Histological Examination of an Adult Human Albino's Eyeball, with a Note on Mesoblastic Pigmentation in Fœtal Eyes.—J. Gray: The Relation of Spermatozoa to Certain Electrolytes, II.

LINNEAN SOCIETY, at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles A. Ballance: The Surgery of the Heart (Bradshaw Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Civil Engineers), at 6.—Capt. J. M. Scott Maxwell: Scientific Management—A Solution of the "Capital and Labour" Problem.

OPTICAL SOCIETY, at 7.30.—Experimental and Conversational Evening.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (28 Victoria Street), at 8.—Debate: Worm *vs.* Bevel Drive.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Discussion: The Late Effects of Injuries to the Nervous System.

FRIDAY, DECEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Consideration of the Theory of Relativity. Discussion to be opened by Prof. Eddington.

PHYSICAL SOCIETY OF LONDON, at 5.—Prof. W. M. Coleman: First Steps in the Experimental Analysis of a Galvanic Cell.—J. W. T. Walsh: Radiation from a Perfectly Diffusing Circular Disc.—Dr. N. W. McLachlan: A Comparative Method of Testing Thermionic Valves for Passing no Reverse Current at High Voltages.—Dr. A. O. Rankine: Recording and Reproducing Sounds by Means of Light.

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.

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